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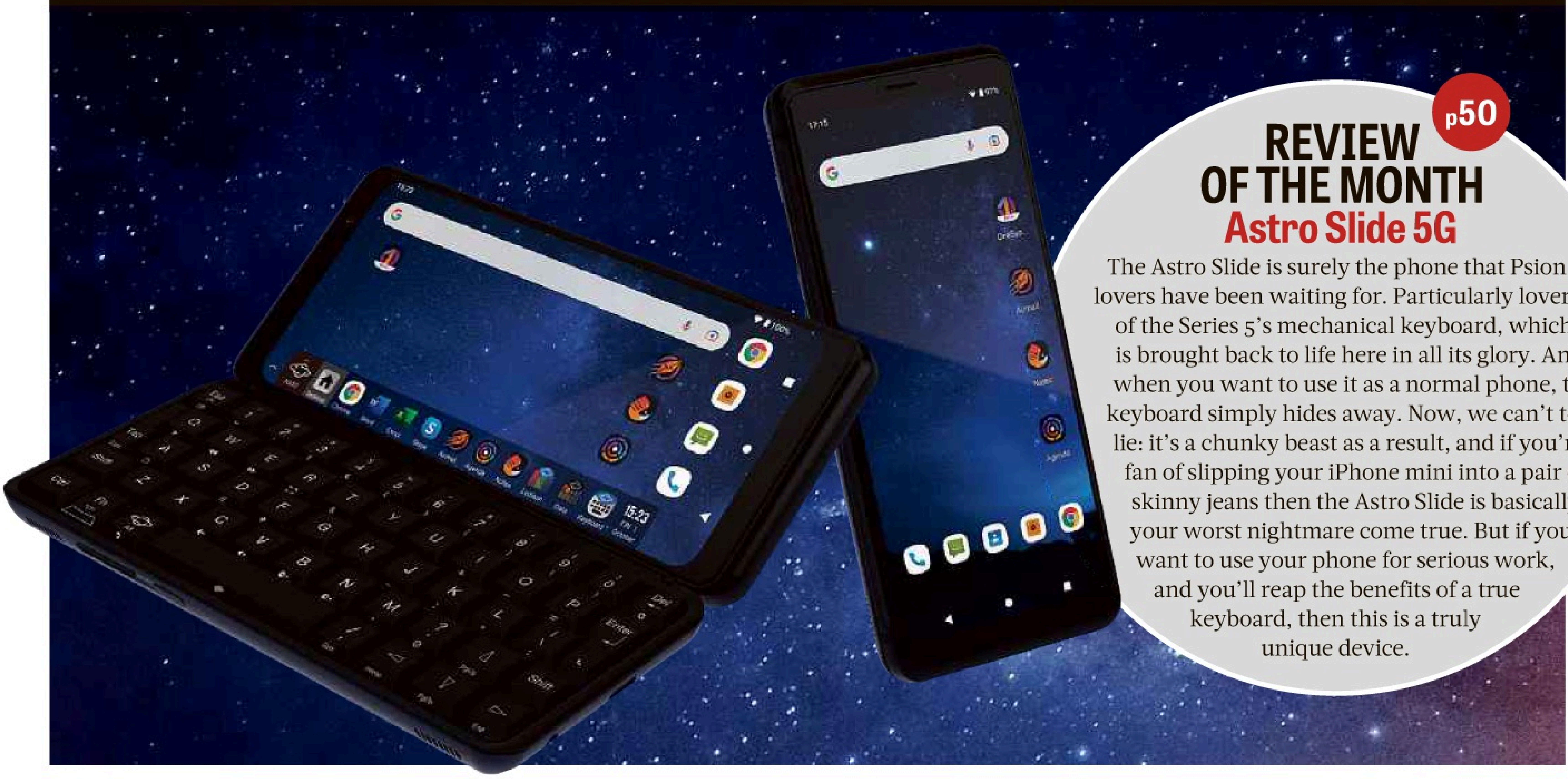

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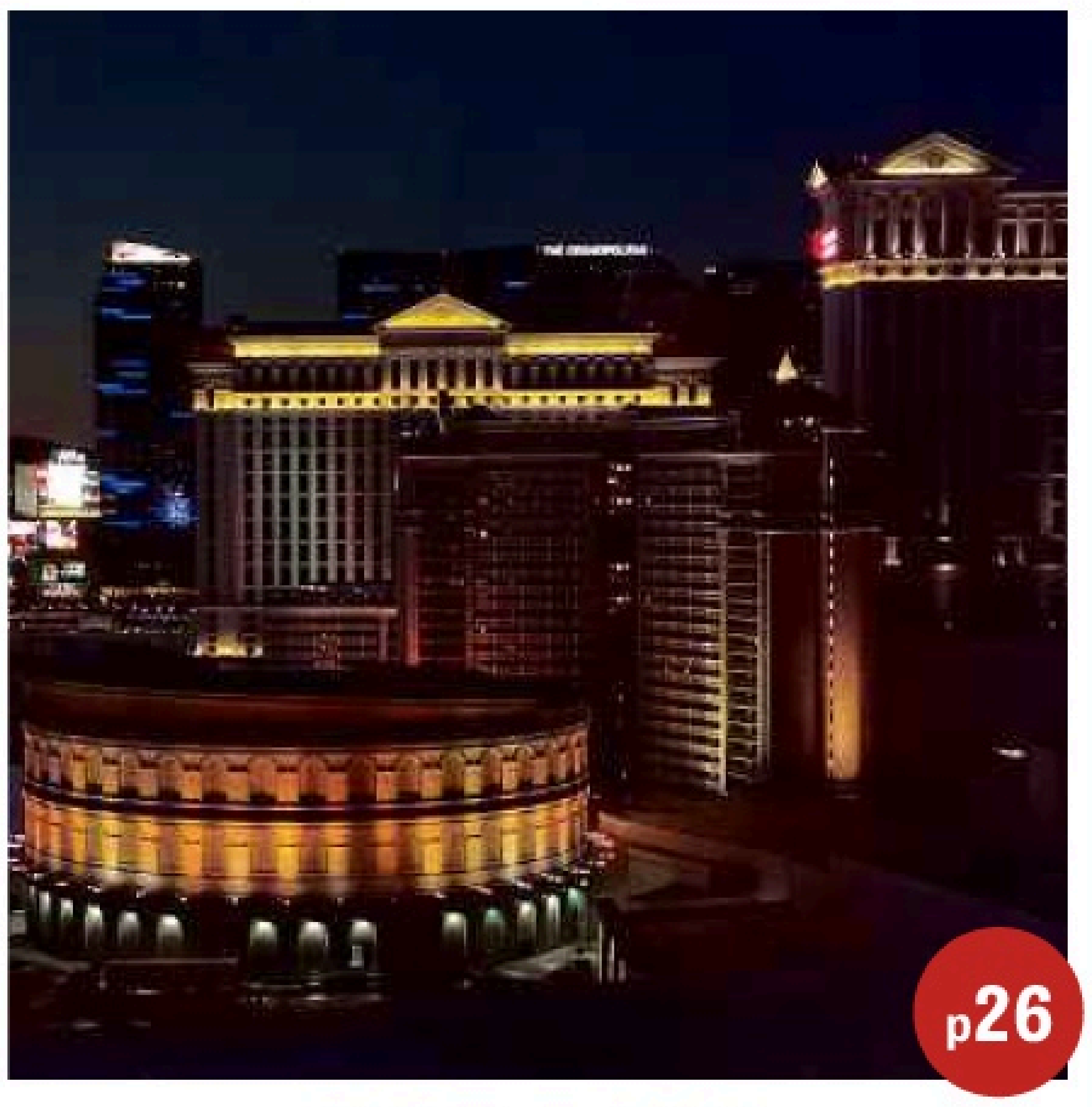
REVIEW OF THE MONTH

Astro Slide 5G

The Astro Slide is surely the phone that Psion lovers have been waiting for. Particularly lovers of the Series 5's mechanical keyboard, which is brought back to life here in all its glory. And when you want to use it as a normal phone, the keyboard simply hides away. Now, we can't tell a lie: it's a chunky beast as a result, and if you're a fan of slipping your iPhone mini into a pair of skinny jeans then the Astro Slide is basically your worst nightmare come true. But if you want to use your phone for serious work, and you'll reap the benefits of a true keyboard, then this is a truly unique device.



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AI has been accused of killing professional chess, but there are plenty of reasons to be upbeat about its impact – and ones that may draw you back into playing yourself.

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Battery technology has lagged behind every other laptop component. Why? And could we be on the threshold of some big breakthroughs? Darien-Graham Smith reveals all.

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Stephen Williams

Okay, Stephen doesn't really look like this – but he's our person of the month as he tore apart his broken Commodore 64 and then rebuilt it with Lego. Aside from the motherboard, which he replaced with a Raspberry Pi. Read his story, and similar Pi-based resurrections of retro PCs, from p123.

THE LABS IN ONE NUMBER

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Whether you're looking to upgrade to Windows 11 or simply want a new laptop, our comprehensive group test of 15 contenders is sure to put temptation in your way.

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PCSpecialist

Then I saw her AI face, and now I'm a metaverse believer

Me of a month ago would be very disappointed with me of today. "You've fallen for the hype," old me would say. "You've drunk so much Kool-Aid it's pickled what's left of your pathetic brain cells."

But that cynical and rather rude yester-me hadn't been to this year's CES (*see p26*), hadn't wandered the halls of Eureka Park and seen the scattering of seeds that will become the metaverse. For yes, I'm a believer.

Now, before you check to see if this month's magazine has been sponsored by the corporate entity formerly known as Facebook, let me explain First of all, I don't think we're all going to be spending our lives living in a *Ready Player One*-like virtual reality. The metaverse – I wish I could think of a better word! – will shift in shape and form over time. There is no one metaverse, just as there is no one defining moment in the history of the internet. Like language, it twists, adapts and is reimagined by each generation.

What I saw at CES were the foundational technologies that will mould the metaverse over the next decade. Some will require eyewear to enhance what we see, with one example being virtual holiday tours – not necessarily to replace trips abroad, although given some holidaymakers' desire to "do" a country in a day it wouldn't be a surprise if they opt to forgo the hassle of plane journeys for a bite-sized package tour of London in minutes. Instead, virtual tours will help us pick exactly where we want to go and which hotels we want to stay in.

This isn't a new idea. What is new is how realistic things are starting to become, and the blurring of the lines between what is real and what is "meta". Just consider films where CGI-generated backdrops are indiscernible from genuine footage. Or the demo I watched at CES, where a company took a scene from an American TV show and regenerated the actor's mouth movements and voice so that he was talking in Korean rather than English, complete with realistic emotional intonations.

Another CES demo saw an avatar of a doctor gazing at viewers from a 50in LG TV, dispensing advice to an elderly lady who was recovering from an operation. The AI doctor asked, in natural language, how the lady was and whether she was taking her medication. She then offered to guide her through a selection of simple rehabilitation exercises. This was a two-way conversation that appeared far superior to the rushed ten-minute chats many patients have with their harassed GP.

This isn't the metaverse sold to us by a floating Mark Zuckerberg. That's something you can already experience via powerful VR headsets should you wish to. This is a metaverse that solves real-world problems using technologies that are moving into the mainstream: AI in its many forms, VR/AR glasses, and a gargantuan amount of data to create realistic digital twins of the real world.

The metaverse is coming. Aspects of it are already here. And if old-me is still reading, allow me to assure you that I've never drunk a drop of Kool-Aid in my life.

Tim Danton
Editor-in-chief

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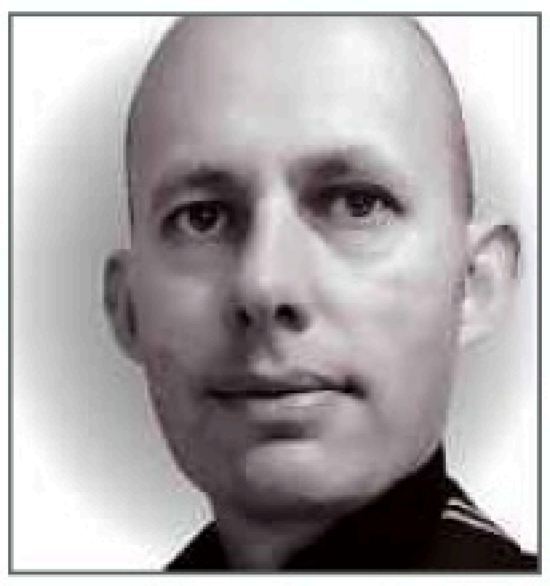
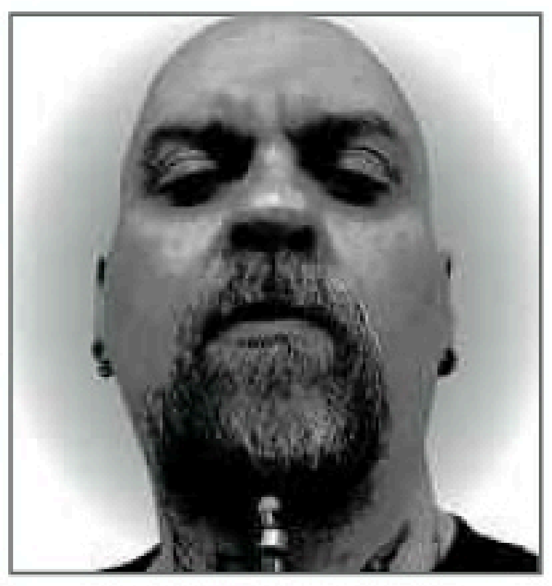


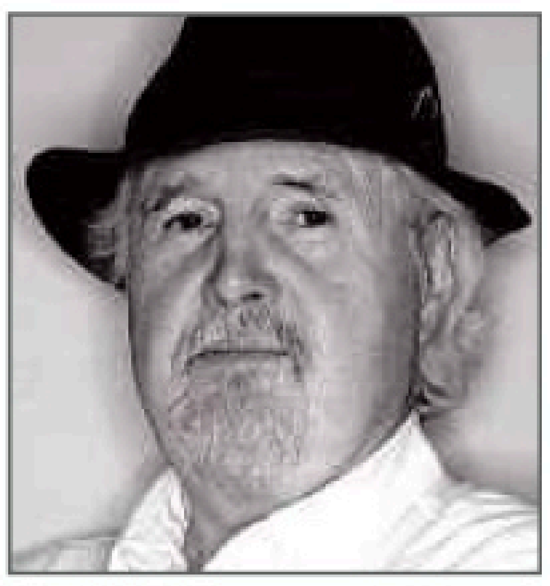
Nik Rawlinson

Still paying for a landline? Nik explains how much you could save by moving to VoIP, unearths the hidden benefits of switching and reveals the practical steps you need to take. See p42



Davey Winder

Alongside his regular Real World Computing column on p118, Davey explains exactly what to do if an online attacker gets its hands on your business's data. Discover your best response on p103



Dick Pountain

A broken amplifier for his hi-fi, with no easy replacement to be found, prompts Dick to tread the line between digital and analogue with spectacular effect. Head to p20 to discover why

Olivia Whitcroft

If you aren't baking data protection into the design of your new products, your customers may turn their noses up. Lawyer Olivia Whitcroft reveals the recipe for success from p116

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We mark CES 2022 – a mix of virtual and physical exhibition – with a ten-page article this month. But we wonder: have tech trade shows had their day?

"My column this month (*see p7*) and the CES feature (*see p26*) should make it abundantly clear where I stand on this one. Be safe, be realistic about numbers, but the tech trade show has an invaluable place on the calendar and I've missed them all, badly, these past two years."

"Hard to believe they can survive at their old scale: costs of stands, travel, etc, combined with health concerns over Covid. But perhaps smaller, shorter face-to-face events with only one or a few brands will survive – online isn't always a good substitute for hands-on."

"No way. Press releases, videoconferences and metaverse projections are no substitute for gazing on a new gadget with your own eyes and holding it in your own hands."

"If you'd asked me three years ago, when I was getting tired of the annual schlep to CES, I'd have said yes. Now, I find myself really missing the chance to see all that tech in one place."

"Even before Covid, there seemed to be a trend for general purpose events to fade out, and narrow-focus events – single vendor, or single subject – to take centre stage. Conventions are also useful for schmooze budgets: not bribery or corruption, just having some way to treat your client to a nice lunch."

"I hope not, but a refresh is required as they had become unappealing to many retailers. Too many stories of 'exclusive show deals' already available online for £50 cheaper. I miss discovering amazing products from small manufacturers who really know their stuff."

"No. Trade shows remain the only place to ferret out the unusual, the rare and the downright silly. You don't get that on a Zoom call."

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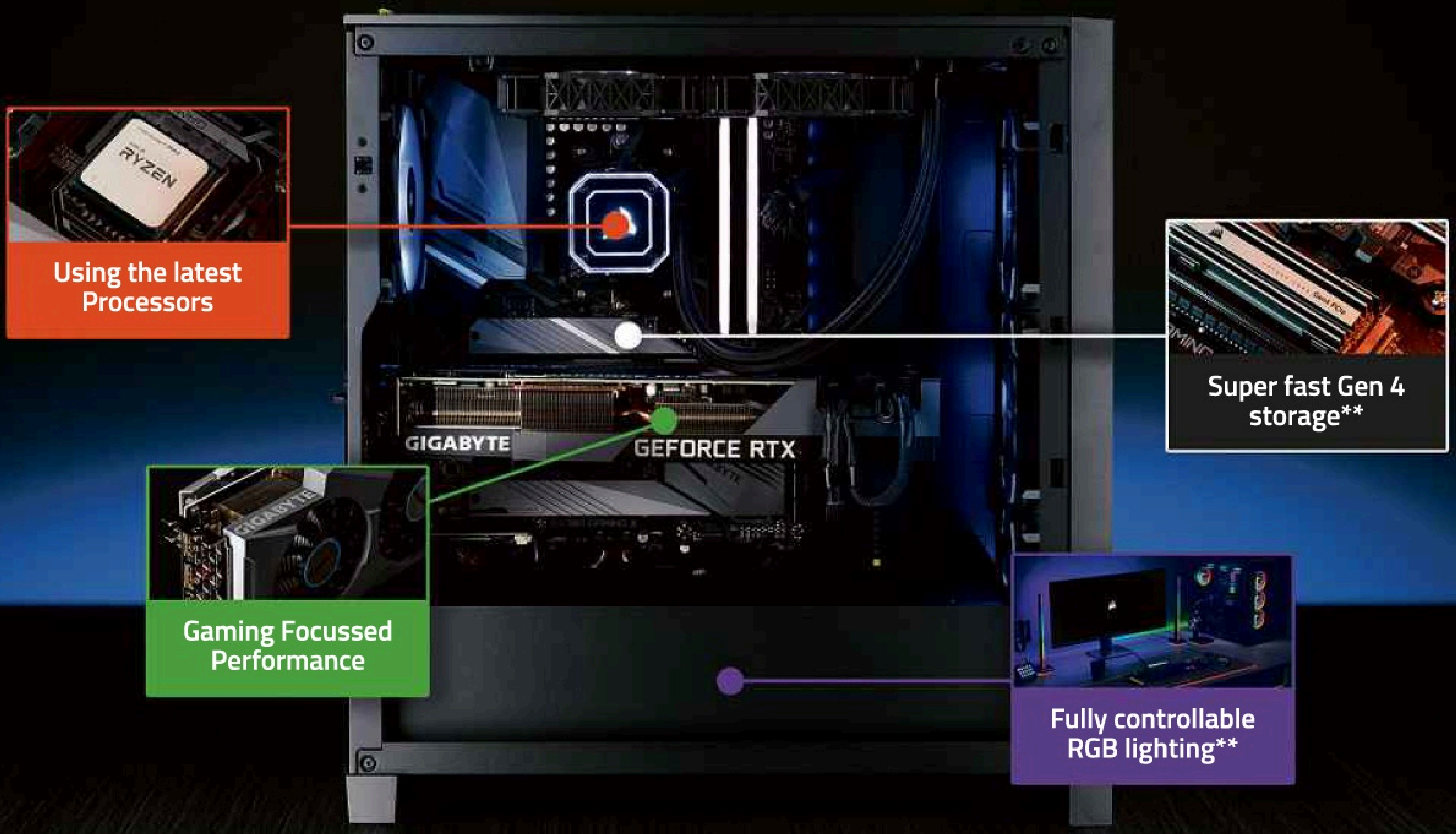
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Play fair: British regulator targets Apple and Google

Competition authority says mobile market has become a two-horse race

Apple and Google are exercising a "vice-like grip" over mobile devices, according to the UK's Competition and Markets Authority (CMA), which is investigating how two of tech's biggest names have "too much control" over the two major mobile operating systems.

The regulatory scrutiny could result in significant changes to how both app stores work. Options on the table include measures such as obliging the two companies to make it easier to switch between iOS and Android, and opening up in-app payments so users can use third-party payment platforms, instead of being forced to use Apple or Google Pay.

One suggestion, buried deep in the report, even proposes that Apple could be obliged to make iMessage available on Android, so that it isn't only iPhone users who can send more multimedia-rich messages to each other via the operating system's baked-in text message client.

The CMA's lengthy interim report goes into detail on several aspects of how the mobile platforms entrench their parents' power. These include Apple's insistence that iOS only support WebKit-rendered browsers, and the company's heavy-handed and seemingly arbitrary rules against game-streaming apps, which have forced Microsoft's Xbox Cloud Gaming to use a browser-based web app, instead of offering a fully fledged app for download in the App Store.

Bigger benefits

The report suggests that the app store domination means the sector faces less competition, and that consumers have fewer meaningful choices. But what about situations where the tight duopoly could be beneficial?

For example, by restricting the side-loading of apps in the case of iOS, or making it obscure or difficult in the case of Android, it arguably helps to keep the non-technically minded majority of mobile users safe online (even if it irritates many *PC Pro* readers).

"We are mindful that there are some genuine trade-offs here between competition and security, and also potentially in relation to competition, privacy and online safety, but we think a balance can be struck," said Tom Fish, the CMA's assistant director of markets.

"One of the key challenges we are facing within the study is trying to cut through and identify where there's really strong merit in those arguments."

A final report is due for publication in the summer and is expected to take a firmer view on exactly what action – if any – should be taken against the companies. The CMA's recommendations will be considered by the government's Digital Markets Unit, a new body that will regulate big tech companies that are deemed to have "strategic market status", in a bid to address the challenges posed by companies such as Apple and Google, which extend their tentacles into numerous aspects of our lives at the same time.

> **"One suggestion is that Apple could be obliged to make iMessage available on Android"**

But there is one final question to ask. Even if Britain does take action, can we actually do anything given these are global companies, building platforms for a worldwide audience?

"There is substantial ongoing coordination between different authorities around the world, and alignment of regulatory approaches, where possible, increases incentives for the companies to engage positively and implement any necessary changes globally," said Fish. "But, that said, I think the UK is in a position to have an impact on its own."

What Apple and Google say

What do the two mobile giants have to say for themselves in response? Here are two short excerpts from their submission to the CMA.

Apple: "Apple is aware that it has some vociferous (and well-resourced) detractors campaigning against it in the UK and elsewhere. These detractors appear to be given significant weight in the SoS [statement of scope] and in relation to the preliminary description of Apple's business model and practices. Apple is confident that the CMA's in-depth investigation will reveal how many of the statements from third parties repeated in the SoS are self-serving, misrepresent Apple's business model and are not grounded in competition law."

Google: "We think the Market Study will show that Android has been a success for us and for competition. It has enabled a substantial increase in the number and range of apps, contributing to an app economy that barely existed a decade ago, and been a key contributor to the development of high-quality, differentiated smartphones and tablets at a wide range of price points."

You can read both companies' submissions in full at **pcpro.link/330cma.**

BlackBerry bows out

BlackBerry leaves a lasting legacy as service comes to an end

It wasn't so long ago that BlackBerry was on top of the world. With famous adherents including Barack Obama and Kim Kardashian, for a time the company's devices were not only an important part of doing business, but a status symbol too.

Fast-forward to 2022, however, and the world is very different. It has now been seven years since the release of the last true BlackBerry OS device, and in early January the company announced that it was finally pulling the plug on supporting its devices. If you fire up your old phone, you should expect it to "no longer reliably function".

"I think it's a little bit sad," said Anton Boman, who worked on BlackBerry 10 (BB10), the final version of the company's home-grown operating system. "There are very few players left, and I think that kind of leads to less pressure to innovate."

Though BlackBerry was ultimately eclipsed by iOS and Android, even 2013's BB10 introduced several new design ideas that were copied across the industry. "Before BB10, everything was about utilising the small screen, everything was a full screen experience," said Marcus Eriksson, who left the company alongside Boman and six other colleagues to launch Swedish design firm TOPP Design.

"I think the multitasking and switching between apps with gestures and peeking to see how many notifications was quite innovative," said Eriksson, referring to how in BB10, a swipe from the left of the screen would reveal a "hub" containing notifications on incoming messages and emails.

Ironically, given BlackBerry's famous physical keyboard, what Boman, Eriksson and their BB10 colleagues realised is something fundamental about interacting with touchscreens. "What was being talked about was this idea that pressing glass is a very unsatisfactory feeling compared to physical keys. [So] we also looked at how we can get rid of all this pressing and start using gestures, because gestures actually feel good on glass."

It's hard to remember it now, but BB10 was actually ahead of iOS and Android in this respect, which still relied on physical home buttons and taps on the screen for most functionality. It was only after BlackBerry that Apple introduced a smooth slide up from the bottom of the screen to switch between apps, for example.

■ Cracking complexity

So, are there any lessons that shouldn't be forgotten, as BlackBerry OS fades into history?

"If you want mass adoption, you have to obviously make it super simple. But [everything] in our life is not necessarily super simple," said Eriksson. "So how can you then have depth to that experience? For example, the inbox and the notification handling on a BlackBerry is something that you should be able to get at first glance, but by living with this technology for years, it should do more for you, it should grow with you, and have tons of functionality."

It's an ethos that his work on BB10 has instilled in him as he works on other projects today.

"When we joined [BlackBerry], there was a bit of a tension of how can we make it simpler without losing the power. And I think today, when I look at a lot of products, I feel they're under-delivering, that they could do so much more, but a lot of it is being stripped down because of complexity. And that, I think, is something that we brought with us and I'm trying to be like, actually, how can we make people as powerful as possible without requiring a PhD to use it?"

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Will “Web3” revolutionise the web again?

The third generation of the web promises to put us in control of our data – but not everybody is convinced, finds James O’Malley

In the beginning, Tim Berners-Lee created the World Wide Web. It was basic by modern standards, composed of static pages and limited interaction. It was on this foundation that the modern tech giants – the likes of Amazon, Facebook and Google – created something new. “Web 2.0” is characterised by dynamic, mobile-first, digital services and social media, underpinned by large platforms, and is the web we’re all familiar with today.

Now a new generation may be imminent, and it has captured the imaginations of the Silicon Valley chattering class – a technological paradigm that has been termed “Web3” by Gavin Wood, a co-founder of the Ethereum cryptocurrency.

But what exactly “Web3” is supposed to be is surprisingly hard to define.

“You always have the feeling you don’t really know what it is because even the people who claim to do it can’t often explain what it is that they’re doing and why they do it,” said Jurgen Geuter, a sociotechnologist who studies the intersection of technology and politics.

Awkwardly, then, it isn’t easy to explain what Web3 means, as it has become a catch-all term for a bucket of futuristic technologies, and some of the ideas associated with it intermingle with similarly vague high-concept ideas such the metaverse.

However, there is one common theme: Web3 advocates tend to envisage the entire web reimagined and rebuilt using the blockchain. So, here’s our best attempt to explain how Web3 might work – and answer the question of whether it really could be the future of the web.

Take back control

“Web3 is more about being self-sovereign, about being decentralised, and not having a sole reliance on massive corporations and the services they provide to us,” said Justin Bingham, chief technical officer at Janeiro Digital, a company that builds decentralised software tools.

“Self-sovereign” refers to a system of digital identity where the user maintains full control over when and where their identity data is used, instead of letting, for example, Google or Facebook decide. In fact, if Web3 is realised, it will conceivably remove the need for large companies to manage our digital lives.

“The ideal dream with Web3 is much more of a trust-based internet,” said Craig Beddis, the CEO of Hadean, a distributed computing firm that provides decentralised computational power to companies such as Microsoft, Oracle and Epic Games. “There’s a lot more freedom of choice, [and] the privacy element of it will be massively improved because you’re not locked into services.

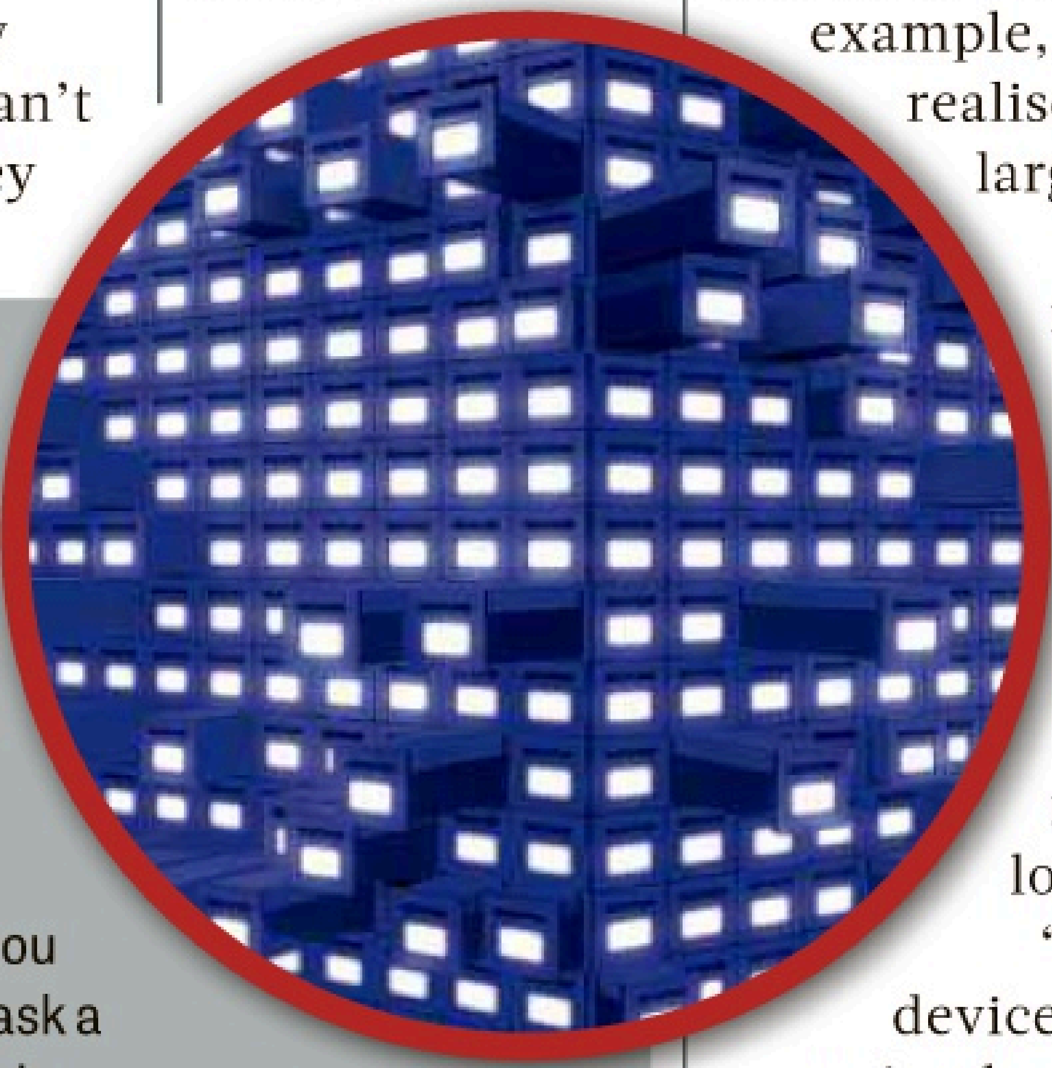
“In a Web3 world we’re not as bound to a device or a service or a hosting provider. That for me is where it could take us,” he added.

In essence, then, Web3 is the idea that all of your personal data belongs to you, and that it should be stored on a blockchain, rather than on other companies’ servers. And this control isn’t just good for your privacy, but it makes your data more interoperable.

“You might have some data that’s coming from a nutrition application that you’re using, that your doctor could find really useful if you could share it with them,” said Bingham, “but they’re not [currently] designed to connect and talk to each other.”

Enter Web3, where we have full “self-sovereign” control over our data. In this new era “you’ll be able to make the data that you have available to whoever you think it makes sense to make it available to, in a way that’s first completely based on your consent,” said Bingham.

BELOW Blockchain technology is considered a key part of Web3



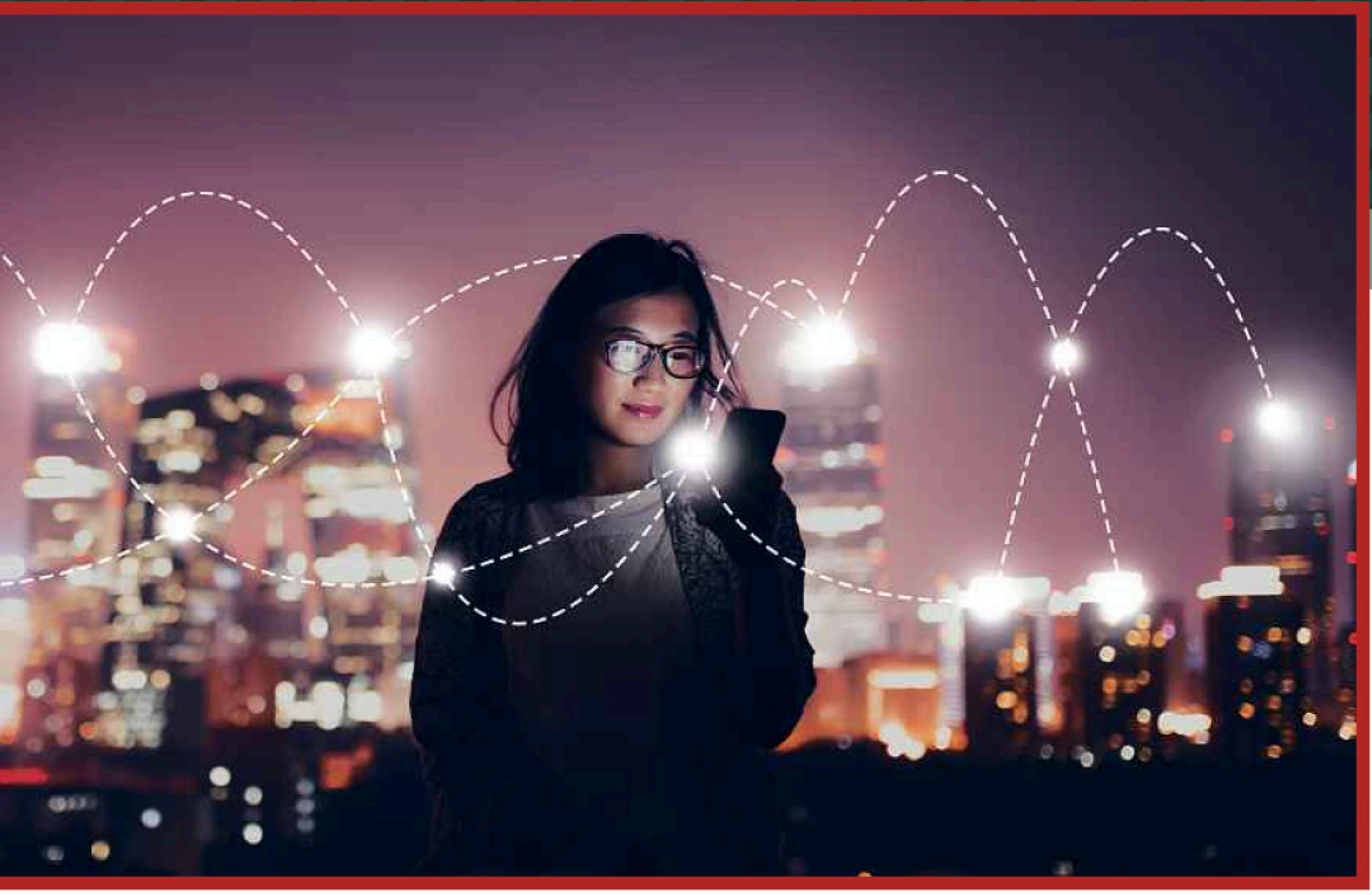
Er, what is the blockchain again?

The blockchain, the core technology at the heart of the Web3 noise, is most famous as the backbone of cryptocurrencies such as Bitcoin and Ethereum. It’s the name given to the ledger where transactions are recorded, so when you send or receive money, it is recorded on the blockchain, which acts like a database.

Crucially, unlike a traditional database, the blockchain is not stored in any one place or is the property of any one institution. Instead, it is “distributed”, with anonymised transaction logs stored by other blockchain users.

It’s a clever idea because, thanks to complex maths and a lot of computing power, it essentially creates a database you can trust is accurate out of thin air. If you want to verify money really was transferred, you don’t need to ask a central authority. Instead, you check the copies of the ledger held by other users, and if they all agree you can be confident the transaction is legit.

Though the technology is most associated with cryptocurrency, the same technology can be used to store other data, too – pretty much anything that can be stored in a database. And this is why Web3 advocates think it is so powerful. If they’re right, it could conceivably replace not only our bank accounts, but every other database in our lives, too.



ABOVE Advocates believe Web3 will let us take back control of our data

In Bingham's view, this could make the apps and services built on Web3 principles even better. "If there's no walled gardens, every interaction that you have around your broader data set is enriching that data set," he said. "You'll find that the applications that you use are much smarter, because you can give them access to a broader spectrum of information. If you find that you don't like how they're using that access, you can cut them off.

"Because the data is all designed to be interoperable, you'll get more choice. And so it will be a more equitable playing field."

The obvious next question is how we get there from where the web is now. This is something Bingham is working on, as his company is working with the NHS on making blockchain-distributed electronic health records interoperable with other, more traditional NHS systems.

"If we can make this work with health data, we can make it work with anything," he said.

Meet the detractors

Even though Web3 is currently little more than ideas scribbled on a whiteboard, the principles behind it and proposals about how it might work technically have already proved controversial, and not everyone is a fan.

"Web3 is a grift," said Molly White, a software developer and the creator of **web3isgoinggreat.com**, a website that catalogues negative stories about crypto, NFTs and other blockchain tools that fall under the Web3 umbrella. "The entire point of it is to convince people that countless cryptocurrencies or ape JPEGs or whatever else actually have value, at least long enough for the creators or early adopters to make money and get out before the whole thing collapses."

In White's view, the very premise of Web3 as a new, decentralising force is flawed. "Many proponents of Web3 present decentralisation as this big new idea when in reality decentralisation has been built into the web since day one," she said. "Concepts like peer-to-peer sharing and even web hosting, federated social networks and self-governing communities have been around for a very long time, and blockchains are not necessary for any of them."

Even if true decentralisation can be achieved, this might not actually be desirable. Moxie Marlinspike, the founder of messaging app Signal, recently published a blog post laying out his criticisms, which centred on the fact that Web3 requires standards to be agreed across the tech industry, which is a tortuous process compared to how platforms operated by one company can make changes and innovate much more quickly.

"If something is truly decentralised, it becomes very difficult to change, and often remains stuck in time," Marlinspike wrote. "That is a problem for technology, because the rest of the ecosystem is moving very quickly, and if you don't keep up you will fail. "

He goes on to cite NFT marketplace OpenSea as an example. Although the underlying tokens are stored on the blockchain, OpenSea's developers have, in true web 2.0 fashion, built their own proprietary tools on top to make the platform more useful.

So is there any value in what the Web3 advocates are proposing? "I don't think there are good or useful applications," said White. "The projects that do attempt to use these technologies for benevolent purposes would be better served by proper, efficient databases."

Meanwhile, Geuter sees Web3 as not just a technological project, but a political one too. "It's a very libertarian crowd," he said. "They build this technology and through this structure of ownership, they gain resistance to censorship, they gain freedom, which mostly means freedom from restrictions of what you can say. Also restrictions from tax laws, for example, and other regulations."

He gives the examples of how in his native Germany, displaying the Nazi swastika is banned in most cases, but in a Web3 world, moderators wouldn't have the choice to remove content at all.

"Sometimes they claim Web3 is apolitical, like 'we just write code, and we're not into politics'," Geuter explained. "But I think it's anti-political. I think what they try to build is technology that makes political discourse impossible. Because you can no longer argue and say we don't think this is okay."

> **"Web3 leads to a very exciting era where the internet goes back to what its original incarnation was supposed to be"**

Making it happen

So that, in a nutshell, is some of the theory behind Web3. But will it ever actually happen? Will we wake up one day to find we are logging on as our sovereign selves? "[Web3] leads, I think, to a very exciting era where the internet goes back to what the original incarnation of the internet was supposed to be," said Beddis. "It was about the people and the power and freedom to communicate and exchange points of view and perspectives and data and transact."

But White isn't so sure Web3 will ever be taken seriously. "It may for a while, while the grift can be maintained and people believe there is money to be made. But I don't expect it will endure, no." ●

The A-List

The best products on the market, as picked by our editors

PREMIUM LAPTOPS

Apple MacBook Pro 14in

Stunning creative power from £1,899

from apple.com/uk

Alongside its 16in sibling, this is simply the world's best laptop for demanding users. The amount of power on tap via the M1 Pro or M1 Max processor is staggering, and it's backed up by a terrific screen and stunning battery life. With all the ports you could ask for, the only negatives are its relative bulk (especially compared to the Air) and high price.
REVIEW Issue 328, p58

ALTERNATIVES

Samsung Galaxy Book Pro (15.6in)
A powerful laptop with a 15.6in AMOLED screen that weighs a mere 1.05kg? And with stonking battery life too? The Galaxy Book Pro is a winner. **Core i7, £1,449 from johnlewis.com**
REVIEW Issue 323, p50

Apple MacBook Air
If you don't need the power of an M1 Pro or M1 Max, "make do" with the M1 in the MacBook Air and enjoy its super-slim design and relatively light weight at a much lower price. **From £999 from apple.com/uk**
REVIEW Issue 318, p40

NEW ENTRY

Asus ProArt Studiobook 16 OLED
A staggeringly powerful workstation with a gorgeous OLED screen and a highly effective dial for quickly changing settings.
£2,500 from scan.co.uk
REVIEW Issue 330, p56

BUSINESS LAPTOPS

Dynabook Portégé X30W-J-10F

The best convertible money can buy

£1,021 exc VAT from uk.insight.com.

Not only is this 2-in-1 convertible ludicrously light and slim, but it also offers a quiet keyboard, performance fireworks, ports a-plenty, a natural-feeling touchscreen and a battery that will see you through a busy working day. Dynabook by name, dynamite by nature.
REVIEW Issue 319, p56

ALTERNATIVES

Lenovo ThinkPad X1 Carbon Gen 9
A business laptop with heaps of luxury, especially if you choose the top-end model with a 3,840 x 2,400 screen. **£1,808 exc VAT from lenovo.com/uk**
REVIEW Issue 327, p60

NEW ENTRY

Asus ExpertBook B1 B1500
You don't need to pay four figures for a well-built business laptop, as this 1.7kg, 15.6in desktop replacement amply demonstrates. **From £499 exc VAT from uk.insight.com**
REVIEW Issue 330, p81

Dell XPS 13
Dell has updated the gorgeous XPS 13 with Intel's 11th-generation Core chips to great effect. The 13.4in screen, touchpad and solid keyboard are similarly sumptuous. **From £909 exc VAT from dell.co.uk**
REVIEW Issue 317, p50

GAMING LAPTOPS

Lenovo Legion 7 (Gen 6)

GeForce RTX 3080 graphics for £1,999

from very.co.uk

The fact you can buy a similarly specified machine for over £3,000 hammers home just how good value this laptop is. Not only do you get superb performance in games and everyday tasks, but the Legion 7 also comes with a high-quality 16in 2,560 x 1,600 screen and the ability to upgrade the 16GB RAM and 1TB SSD yourself.
REVIEW Issue 326, p58

ALTERNATIVES

Asus TUF Gaming A15 (2021)
The TUF Gaming A15 is a great choice if you need both power and portability, thanks to a Ryzen 7 5800H processor and RTX 3070 graphics. **£1,600 from asus.com**
REVIEW Issue 319, p51

Asus ROG Zephyrus S17 GX703
The combination of RTX 3080 graphics and Intel's Core i9-11900H CPU in our test model (GX703HS-KF004R) led to predictably blistering performance. **£3,000 from scan.co.uk**
REVIEW Issue 323, p56

Lenovo Legion 5 (Gen 6)
An RTX 3070 is the star, but it's backed by a high-quality 15.6in 165Hz screen, Ryzen 7 CPU and a solid aluminium chassis. **£1,300 from box.co.uk**
REVIEW Issue 326, p60

EVERYDAY LAPTOPS

NEW ENTRY

HP Pavilion 14

Stylish laptop from £549

from hp.com

This slim 1.4kg laptop is a superb choice for anyone on a tighter budget, with the Core i3 version costing £549. We tested the Core i5 edition (part code 2G2E2A#ABU), which costs £680, and found it struck an excellent balance between speed and battery life – around ten hours.
REVIEW Issue 330, p85

ALTERNATIVES

NEW ENTRY

Huawei MateBook 14s
We like its power, its 3:2 14.2in screen, its 1TB SSD, but the £1,300 list price is too high, although Huawei often reduces this on its website. **£1,300 from consumer.huawei.com**
REVIEW Issue 330, p86

NEW ENTRY

HP Envy 14
This well-built laptop is a great choice. The £1,400 unit we were sent for testing (code 30B00EA#ABU) was too pricey for an award, but check out cheaper versions. **From £1,100 from hp.com.**
REVIEW Issue 330, p84

Microsoft Surface Laptop Go
A superb travelling companion, the Go offers all the power you need in a stylish and well-built 1.1kg chassis. **128GB, £680 from microsoft.com/uk**
REVIEW Issue 316, p48

CHROMEBOOKS

Asus Chromebook Flip C436F

Flexible laptop for £799

from argos.co.uk

The Flip C436F is a fast, flexible laptop with a slim magnesium alloy chassis that's easy on the eye. With a 256GB SSD, a Core i5 processor and fantastic 14in Full HD screen, it's a fine choice for demanding users.
REVIEW Issue 321, p83

Asus Chromebook CX9

Aimed squarely at business users, this exceptionally quick machine – with a Core i7 processor, 16GB of RAM and a 512GB SSD – drips quality throughout its aluminium alloy chassis. Add a glossy 4K 14in screen, plus a low weight of just 1.05kg, and it justifies its high price. **£1,300 from argos.co.uk**
REVIEW Issue 329, p56

Lenovo IdeaPad Duet

The Chromebook answer to Microsoft's Surface tablets, this is a seriously versatile device – albeit not the speediest (although we never found it to be painfully slow while carrying out everyday tasks). For this price, and with a 16hrs 14mins battery life, the Duet is a great choice. **£280 from lenovo.com/gb**
REVIEW Issue 321, p86

EVERYDAY PCs

Apple Mac mini (M1)

Mini masterpiece from £699

from apple.com/uk

Apple has applied its M1 formula to the diminutive Mac mini with predictably stellar results: superb performance in native apps to the point where the mini is challenging the much more expensive iMac for speed. If the software you want to run is compatible with the M1, it's an obvious, quiet and bargain choice that will get you through your working day without fuss.
REVIEW Issue 318, p54

Stormforce Onyx GTX 1650

A well-balanced system that offers strong 1080p gaming performance at lower-quality settings along with straight-line speed courtesy of the Intel Core i3-10015F processor. And it's well put together, too, with plenty of potential for upgrades. **£699 from stormforcegaming.co.uk**
REVIEW Issue 327, p55

Chillblast Fusion Prime 11 Gaming PC

You may decide to upgrade the GeForce GTX 1650 when RTX graphics cards become more affordable, but for now this is a classy and quiet-running system with a Ryzen 5 5600X processor as a firm foundation. **£1,000 from chillblast.com**
REVIEW Issue 327, p56

ENTHUSIAST PCs

NEW ENTRY

Scan 3XS Vengeance Ti

Core i9-12900K for £3,500

from scan.co.uk

This PC has it all: top-end Alder Lake processor, RTX 3080 Ti graphics, 32GB of DDR5 memory and a supporting cast to die for. Wrapped up in a high-quality Corsair case, it's obvious where all your money is going.
REVIEW Issue 328, p53

CyberPower GBC Next Day PC

It looks modest next to the Scan, but this is a powerful system thanks to its 12th gen Core i7 processor and RTX 3070 graphics. If you want to upgrade the 16GB of RAM or 1TB SSD, there's plenty of space in the Cooler Master chassis. **£1,999 from cyberpowerystem.co.uk**
REVIEW Issue 328, p54

PCSpecialist Titan Spark

This falls under the category of "buy it while you can". A terrific value system where a Core i5-12600KF and GeForce RTX 3060 Ti combine to brilliant effect. And there's overclocking potential too. **£1,350 from pcspecialist.co.uk/reviews**
REVIEW Issue 330, p52

BUSINESS PCs

StonePC Lite (Ryzen)

Ryzen 4000 PCs, from £389 exc VAT

from stonegroup.co.uk

Not one but a trio of compact, great-value PCs that are based on AMD's Ryzen 4000 Pro Series of processors. The 4650G version, for £459 excluding VAT, hits the sweet spot for performance and price, with StonePC also including 16GB of RAM and a 500GB SATA SSD.
REVIEW Issue 316, p56

HP EliteDesk 705 G5

Based on AMD's Ryzen 5 Pro 3400GE chip, this minuscule machine won't win awards for speed – or indeed quietness – but it's still more than speedy enough for business use (including for remote workers at home), and is just as secure and manageable as you'd expect from HP. **£698 exc VAT from uk.insight.com**
REVIEW Issue 318, p59

Dell OptiPlex 7090 Ultra

This clever PC slots into a custom monitor stand that you can then attach to any screen with a VESA 100x100 slot – which is virtually all of them. We tested the Intel Core i5 version with 16GB of RAM and a 512GB SSD, which proved more than fast enough for office-based tasks **From £659 exc VAT from dell.co.uk**
REVIEW Issue 321, p48

WORKSTATIONS

Workstation Specialists WS-1640A-G4

64-core beast, £6,667 exc VAT

from workstationspecialists.com

There's no doubting this workstation's centrepiece: a 64-core AMD Ryzen Threadripper 3990X that, with the aid of Nvidia's Quadro RTX A5000 graphics, tears through both rendering and modelling tasks. Add a 2TB PCI-E 4 SSD and 128GB of RAM, and it's the fastest all-round machine we've ever tested.
REVIEW Issue 325, p87

InterPro IPW-R9

Using AMD's punchy Ryzen 9 5950X, which sports 16 cores, this affordable workstation still has room in the budget for Quadro RTX A4000 graphics. A well-chosen motherboard also offers plenty of room for memory and storage upgrades if and when you need them. **£2,500 exc VAT from ipworkstations.com**
REVIEW Issue 325, p85

Armari Magnetar M64TP-AW1200G3

A promising debut for AMD's 32-core Threadripper Pro 3975WX, with 128GB of ECC memory as eight 16GB modules to take advantage of its eight-channel memory support. With the new Radeon Pro W6800 in support, it's a star in 3ds Max. **£6,650 exc VAT from armari.com**
REVIEW Issue 325, p84

TABLETS

Apple iPad Pro 12.9in (2021)

M1 power in your palm from £999

from apple.com/uk

Blurring the boundaries between laptop and tablet like never before, the M1-powered iPad Pro 12.9in is every bit as fast as we expected – and the "Liquid Retina XDR" display is simply phenomenal.
REVIEW Issue 323, p62

Apple iPad (2021)

Apple performs its usual trick of upgrading just enough to keep the iPad affordable and up to date, without treading on the toes of its more luxurious stablemates. The big bezels remain, but a faster processor, more storage and improved camera all add to its appeal. **From £319 from apple.com/uk**
REVIEW Issue 327, p50

Samsung Galaxy Tab S7

If you want a cheap Android tablet, get a Kindle Fire. If you want quality, choose the sumptuous Galaxy Tab S7. In return for your £619 outlay, you receive top-quality construction, a stunning 120Hz 11in display, plenty of power and a nifty stylus in the box. If only Apple was as generous. **£619 from johnlewis.com**
REVIEW Issue 328, p86

EVERYDAY PHONES

NEW ENTRY

OnePlus Nord 2 5G

Ultimate all-rounder from £399

from oneplus.com/uk

OnePlus packs a surprise with this MediaTek-powered phone, which stormed through our benchmarks – only the Poco F3 can beat it for the price. But with a superior camera, longer-lasting battery and striking design, this is worth the extra £100.
REVIEW Issue 325, p68

Samsung Galaxy A52 5G

The Galaxy A52 5G is one of the most compelling arguments yet for not buying a flagship phone: why bother when you can have a 6.5in 120Hz screen, a high-quality quartet of cameras and a stylish and slim design? The only obvious sacrifice is outright speed. **£399 from samsung.com**
REVIEW Issue 321, p71

Motorola Moto G50

A price drop from £200 to £170 makes the G50 even more tempting than before, and an excellent alternative to the two more expensive phones to the left. Its cameras won't blow you away, but a fine screen, 5G support and incredible battery life make it a snip. **64GB, £170 from motorola.co.uk**
REVIEW Issue 323, p75

PREMIUM PHONES

Apple iPhone 13 Pro Max

Big-screen monster, 128GB, £1,049

from apple.com/uk

Get ready to stretch your fingers and your budget with this 6.7in phone, which sits at the cutting edge for every aspect of smartphone technology: speed, cameras, design, display... it even offers compelling battery life. Not for the small of hand, but if your pockets can cope then this is a brilliant investment.
REVIEW Issue 327, p49

Google Pixel 6 Pro

The Pixel 6 Pro is a superb showhome for Android 12, with Google's Tensor processor and the gorgeous 120Hz 6.7in panel ensuring everything looks slick. Add a quite brilliant camera setup, with software to match the hardware, and the Pixel 6 Pro sits apart from most Android rivals. **128GB, £849 from store.google.com**
REVIEW Issue 328, p68

Samsung Galaxy S21 5G

Despite Samsung's bamboozling decisions to bin the microSD slot and bundled charger, the Galaxy S21 is a simply stunning flagship smartphone that boasts three phenomenal cameras, a stylish design (with the merest whisper of bezels) and bags of pace. It's the pick of the S21 crop. **128GB, £769 from samsung.com/uk**
REVIEW Issue 318, p68

EVERYDAY MONITORS

Philips Brilliance 346P1C

34in curved docking, £563

from shop.bt.com

No-one can match Philips for its mix of quality, features and value, especially when it comes to curved MVA monitors such as this. It's great for casual gamers and busy workers alike, with USB-C docking and superb colours.
REVIEW Issue 326, p93

Eizo FlexScan EV2480

Businesses in particular will love this easy-to-roll-out 24in monitor, with its exceptional five-year warranty, USB-C port for easy docking, excellent viewing angles and delicious whites. And it has the best OSD around.
£309 from wexphotovideo.com
REVIEW Issue 326, p83

Iiyama ProLite XUB2792QSN-B1

If you're on a tight budget but want a high-quality 27in 1440p screen, this is a brilliant choice. There's even USB-C docking, an RJ-45 port and respectable speakers. It's so good it begs the question of why you'd spend more on a 27in monitor. **£300 from box.co.uk**
REVIEW Issue 326, p87

PROFESSIONAL MONITORS

Eizo ColorEdge CG319X

Creative masterclass, £3,960

from wexphotovideo.com

As the price indicates, this monitor is for heavyweight creatives who demand the best in every discipline: HDR video editing, print layouts, professional photography and more besides. With superb coverage and accuracy across all spaces, plus a built-in calibrator, it justifies the investment.
REVIEW Issue 327, p81

BenQ PD2725U

By no means a cheap 4K 27in monitor – unless you compare it to the Eizos – but it marries all-round quality with ease of use thanks to a puck that allows you to quickly move between settings. You can even daisy chain a second Thunderbolt 3 monitor for a monster setup. **£859 from photospecialist.co.uk**
REVIEW Issue 327, p80

Eizo ColorEdge CG279X

Designers who need to work across different disciplines will love how easy it is to switch between the Adobe RGB, DCI-P3 and sRGB colour spaces using the Eizo's fantastic OSD. It's certainly not cheap for a 27in 1440p monitor, but it's packed with quality. **£1,726 from wexphotovideo.com**
REVIEW Issue 327, p84

WEBCAMS

Logitech C925e Business Webcam

Top quality 1080p video, £100

from logitech.com

Logitech remains the supreme ruler of the webcam world and the C925e shows why. None can match its image quality under challenging light conditions and Logitech backs this up with the best software (and compatibility with the likes of Teams) on the market.
REVIEW Issue 321, p73

Aukey PC-W3 1080p Webcam

If the thought of spending £100 on a webcam has you spluttering into your microphone then you should consider this far cheaper but high-quality alternative. Its colours are low-key in comparison to Logitech's, but it still produces a sharp and detailed image. **£30 from aukey.com**
REVIEW Issue 321, p72

Anker PowerConf C300

It may not be able to match the Logitech C925e for all-round quality, but this 1080p webcam supports 60fps capture and includes software that means it can follow you round a room. It's an excellent alternative to our top choice if such features matter to you. **£100 from pcpro.link/324anker**
REVIEW Issue 324, p70

HOME OFFICE PRINTERS

Canon Pixma G650

Bottle-fed MFP, £227

from printerbase.co.uk

We think this might be the breakthrough bottle-fed printer, because not only do you get supremely low running costs (0.4p mono, 1p colour) but also excellent photo results thanks to its six-colour system.
REVIEW Issue 323, p69

Canon Pixma Pro-200

Yes, it's big and it's expensive – and you don't even get a scanner – but the Pixma Pro-200 means that you can print A3 photos with glorious colour accuracy and detail. If you're after an office workhorse, look elsewhere, but it can't be beaten on photo quality. **£450 from johnlewis.com**
REVIEW Issue 320, p80

Brother MFC-J4540DWXL

Home workers will love this inkjet all-in-one. It combines an incredible range of features with all the connectivity you need and extreme ease of use. Output quality is fine, it offers the best cloud support around and the high-capacity ink pack could keep you going for years. **£280 from printerland.co.uk**
REVIEW Issue 328, p100

WORKGROUP PRINTERS

Epson EcoTank ET-5880

Features galore, £1,077 exc VAT

from epson.co.uk

A great office all-in-one with plenty of features, good output quality and top-notch cloud support. Expensive, but phenomenally low running costs will mean SMBs recoup this in no time at all.
REVIEW Issue 323, p97

HP Color LaserJet Pro M255dw

The Color LaserJet Pro M255dw is an excellent choice for smaller businesses thanks to its price, decent running costs (2.6p per mono page), duplex printing and respectable 17ppm speeds. The only fly in the ointment is the slow warm-up time. **£217 exc VAT from store.hp.com**
REVIEW Issue 320, p89

Kyocera Ecosys M6235cidn

A strong contender for small and medium businesses that want good print speeds and great access security. The M6235cidn's large operator panel is very user-friendly, the print quality is excellent and its running costs are surprisingly low. **£696 exc VAT from printerland.co.uk**
REVIEW Issue 323, p98

WIRELESS ROUTERS

Netgear Nighthawk RAX80

Winning Wi-Fi 6 performance, £306

from broadbandbuyer.com

The *Star Wars*-esque Nighthawk RAX offers class-leading Wi-Fi 6 speeds, a feast of connections, a stylish design and an easy-as-the-proverbial-pastry setup process.
REVIEW Issue 318, p82

Asus RT-AX82U

The impressive RT-AX82U punches well above its price when it comes to raw Wi-Fi 6 performance and includes a fistful of useful features – such as an ultrafast 20Gbits/sec USB connector, outbound VPN support, site-blocking and a host of parental controls. **£174 from box.co.uk**
REVIEW Issue 318, p80

Honor Router 3

This affordable Wi-Fi 6 router delivers consistently fast wireless speeds, broad coverage and a modest speed boost for newer hardware – and the Router 3 has a cute design too. If you need more range, you can pick up a second unit to use as an extender. **£55 from amazon.co.uk**
REVIEW Issue 318, p51

MESH WI-FI

Netgear Orbi RBK752

Wide Wi-Fi 6 mesh, £450

from pcpro.link/318net2

More expensive rivals may boast better performance, more connections and a more impressive selection of features, but the user-friendly Orbi RBK752 offers unimpeachable mesh coverage for the price.
REVIEW Issue 318, p83

TP-Link Deco X20

The price below isn't a typo: the Deco X20 makes it possible to upgrade your home network to Wi-Fi 6 – as well as manage its security – for the price of some standalone routers. The included HomeCare functions are also a great bonus for households where lots of devices are fighting over the bandwidth. **£279 from box.co.uk**
REVIEW Issue 318, p84

Asus ZenWiFi AX

The interface and design certainly aren't the prettiest (the nodes look like mini space heaters, while the charcoal version is straight out of the 1980s), but if you're after strong performance, great features and plenty of expansion potential, the ZenWiFi AX is a compelling prospect. **£404 from pcpro.link/318zen**
REVIEW Issue 318, p87

BUSINESS WI-FI

Netgear WAX630

Wi-Fi 6 access point, £229 exc VAT

from broadbandbuyer.com

A great choice of access point for dense Wi-Fi 6 deployments, as its triple radios delivery astounding performance. It's easy to install, with an impressive range of remote management services, and the price is very reasonable, too. **REVIEW Issue 329, p97**

DrayTek VigorAP 1060C

This sits at the upper end of the price spectrum for a dual-band Wi-Fi 6 access point, but it still offers a lot for your money. Performance is impeccable, management choices are extensive and its meshing feature makes it easy to extend your network. **£270 exc VAT from broadbandbuyer.com** **REVIEW Issue 329, p96**

Ubiquiti Networks UniFi U6-LR

It would have been nice to see a 2.5GbE port, but the U6-LR is a fast Wi-Fi 6 access point with good range. It offers a wealth of features for a fair price, and the UniFi cloud-management services are among the best in town. **£159 exc VAT from broadbandbuyer.com** **REVIEW Issue 329, p99**

NAS SERVERS

Synology DS218+

Two-bay NAS, £306

from box.co.uk

The Synology DS218+ is the best two-bay NAS server around, thanks to a dual-core Celeron that gives it some added grunt, an intelligent design that makes adding disks a piece of cake and a wide-ranging spread of apps. **REVIEW Issue 305, p87**

Asustor Nimbustor AS5304T

This is a hugely powerful four-bay NAS that will be overkill for most people – not just due to its speed but also its slightly intimidating user interface – but techies and gamers should investigate the Nimbustor AS5304T for both its speed and flexibility. **£467 from amazon.co.uk** **REVIEW Issue 305, p82**

Synology DS1019+

This five-bay NAS includes many of the features that make the DS218+ to the left such an attractive buy: a superb selection of apps, an elegant hardware design and a good deal of power. And those five bays make it perfect for RAID5 configurations, or Synology's own Hybrid RAID. **£685 from pcpro.link/305synology** **REVIEW Issue 305, p88**

VIDEOCONFERENCING

Logitech Rally Bar

4K meeting room solution, £2,527 exc VAT

from meetingstore.co.uk

This simple and tidy videoconferencing solution combines everything you need into a single unit that can be mounted on a desk or wall. It includes speaker tracking together with video and audio quality that are beyond reproach. A highly versatile system that also looks great. **REVIEW Issue 328, p97**

Maxhub UC S10

With Android in the driving seat, this VC room solution can function as an independent host system, be connected directly to a computer over USB, provide wireless screen sharing services to four users and even become a meeting room wireless hotspot. **£600 exc VAT from onedirect.co.uk** **REVIEW Issue 328, p98**

Bose Videobar VB1

You're paying a premium for the Bose name, but the Videobar VB1 is a class act for huddle spaces and meeting rooms. It's easy to set up, delivers smart auto-framing features and its audio quality is, as you would expect from Bose, a cut above the rest. **£975 exc VAT from business.currys.co.uk** **REVIEW Issue 328, p96**

SCANNERS

Fujitsu ScanSnap iX1600

Hassle-free scanning, £319 exc VAT

from ebuyer.com

Perfect for SMBs and home workers that want fast desktop scanning at a good price. The touchscreen and software combine to make scanning an incredibly swift process. **REVIEW Issue 324, p98**

Canon imageFormula DR-M260

For a 60ppm scanner, it's good value and offers top output quality plus a great software bundle. SMBs that want a high-volume desktop scanner and don't require network support should put it on their shortlist. **£539 exc VAT from printerland.co.uk** **REVIEW Issue 324, p97**

Kodak Scan Station 730EX Plus

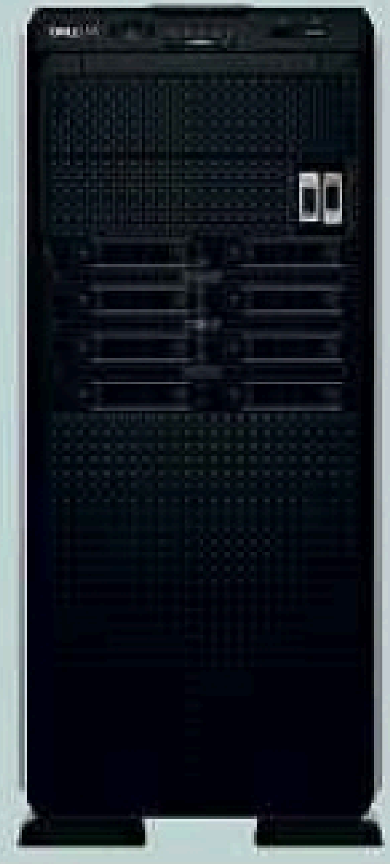
It might make your budget tremble, but if your digitising demands require a dedicated PC, you should consider this smarter alternative from Kodak. It offers great speed, quality and security in an easily managed appliance. **£1,094 exc VAT from lambda-tek.com** **REVIEW Issue 314, p105**

SERVERS

Dell EMC PowerEdge T550

Gen3 Xeon Scalable power, £7,446 exc VAT

from dell.co.uk



A superbly designed tower server that's ideally suited to businesses with demanding workloads. You can configure it to deliver as much power as you're likely to need, and it comes with great management tools at a very tempting price. **REVIEW Issue 327, p100**

Dell EMC PowerEdge T140

The PowerEdge T140 is an ideal candidate for smaller offices that want an affordable on-site server with plenty of room to expand. It packs a powerful hardware package into a space-saving chassis and incudes top-tier remote-management features. **£1,224 exc VAT from dell.co.uk** **REVIEW Issue 314, p104**

Broadberry CyberServe Xeon E-RS100-E10

This represents a powerful hardware package at a price that will please small businesses. We love its low-profile chassis and the fine selection of remote-management tools. It's a great alternative to the Dell EMC servers also listed here. **£983 exc VAT from broadberry.co.uk** **REVIEW Issue 318, p96**

SECURITY SOFTWARE

F-Secure Safe

F-Secure concentrates on the basics: faultless protection with minimal impact on your system's performance – for a low price. **1 PC, 1yr, £19 from pcpro.link/322safe**
REVIEW Issue 322, p83

Kaspersky Internet Security

With plenty of tools and features to play with, the powerful Kaspersky Internet Security goes a long way beyond blocking viruses. And it won yet another *PC Pro* award in our Labs. **1 PC, 1yr, £11 from pcpro.link/322kasp**
REVIEW Issue 322, p84

Avast Free Antivirus

For the second year running, Avast is our top pick for free antivirus software – it's simply lighter on its feet than Microsoft Windows Security, whilst offering fewer false positives. **Free from avast.com**
REVIEW Issue 322, p82

VPNs

NordVPN

NordVPN provides consistent and fast speeds, serious security, great support for video-streaming services and some cost-effective subscription rates. **£44 per year from nordvpn.com**
REVIEW Issue 329, p84

ProtonVPN

ProtonVPN provided one of the best free offerings of all the VPNs in our group test, including unlimited data, but upgrade to benefit from even faster speeds and many more options. **Free from protonvpn.com**
REVIEW Issue 329, p85

Surfshark

A strong rival to NordVPN, especially if you're willing to commit to its two-year contract. It's fast, cheap and a fine choice for people who like to switch to US streaming services. **£44 for two years from surfshark.com**
REVIEW Issue 329, p86

PASSWORD MANAGERS

Bitwarden

Bitwarden has a huge advantage: it's free. It isn't as slick as some paid-for rivals, but it can sync passwords across all devices for no extra charge. **Free from bitwarden.com**
REVIEW Issue 320, p61

Dashlane

A manager that's ideal for beginners, and it even builds in an unlimited (if basic) VPN service. Note you may prefer to buy the Family plan ($60 per year) as this extends the service to six people. **$40 per year (Premium) from dashlane.com**
REVIEW Issue 320, p62

1Password

1Password is targeted at technically minded users who are looking for the last word in security. It even offers a Travel Mode that may ease your mind if surrendering your phone to customs officials. **$24 per year (individual) from 1password.com**
REVIEW Issue 320, p60

BUSINESS BACKUP

Naviko Backup & Replication 10.4

The most versatile backup suite we've seen, supporting a huge number of platforms and backup options. It's a cinch to use and exceedingly good value. **Enterprise, 5 servers, perpetual licence, £479 exc VAT from naviko.com**
REVIEW Issue 326, p103

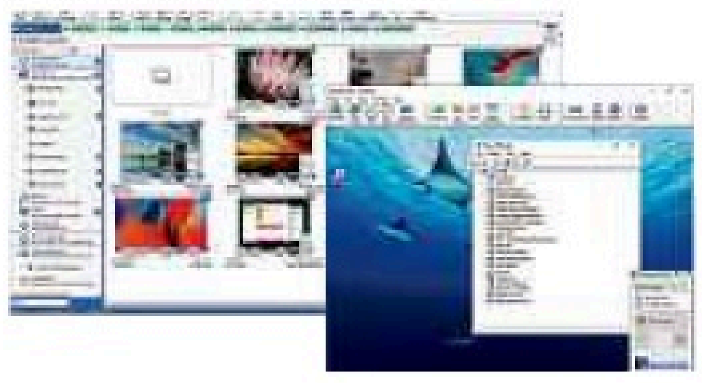
Veritas Backup Exec 21.3

With data deduplication services now extending to cloud backup repositories on top of its traditional strengths, this is a great choice for SMBs. **1yr Bronze subscription, £370 per TB exc VAT from span.com**
REVIEW Issue 326, p105

REMOTE SUPPORT

NetSupport Manager 12.8.6

The best on-premises support solution. It's a cinch to deploy, delivers a huge range of technician tools and the price includes secure services for supporting remote workers. **1-500 systems, perpetual licence, £10 each exc VAT from netsupportmanager.com**
REVIEW Issue 325, p99



ConnectWise Control 21.8

Suited to SMBs and larger organisations that want stiff access security and portal-branding features. It's easy to use with great mobile support. **Starts from £17 per month exc VAT from connectwise.com**
REVIEW Issue 325, p96

VOIP SERVICES

3CX Phone System Pro 16 Update 8

The top choice for small and medium businesses that want to host on-premises IP PBX. It's flexible, affordable and packed with call-handling features. **16SC Pro edition, £554 exc VAT from 3cx.com**
REVIEW Issue 322, p96

RingCentral Office

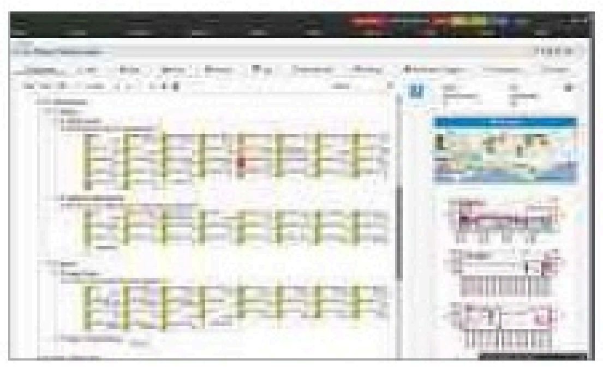
A smart cloud-hosted communications solution with outstanding videoconferencing services. It's easy to deploy and the new desktop apps are impressive. **From £8 exc VAT per user per month from ringcentral.co.uk**
REVIEW Issue 322, p99

NETWORK MONITORING

NEW ENTRY

Paessler PRTG Network Monitor 21.4

PRTG provides a terrific range of sensor options for local devices and cloud services, along with plenty of monitoring facilities, yet it's easy to manage, and comes with an affordable pricing scheme that's perfect for SMBs. **2,500 sensors, 1yr maintenance, £4,950 exc VAT from paessler.com**
REVIEW Issue 330, p97



NEW ENTRY

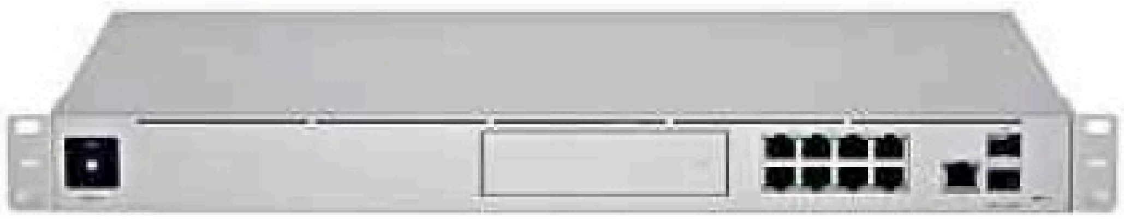
Progress Software WhatsUp Gold 2021.1

WhatsUpGold has flexible licensing plans, a smart web console that will keep downtime to a minimum and powerful new log management features. **25 devices, Premium licence, $2,740 from whatsupgold.com**
REVIEW Issue 330, p98

SECURITY APPLIANCES

Ubiquiti Networks UniFi Dream Machine Pro

An impressive piece of kit that delivers an incredible range of easily managed features at a low price. There are some great UTM appliances on the market, but the Ubiquiti simply does it all. **£298 exc VAT from broadbandbuyer.com**
REVIEW Issue 327, p101



Fortinet FortiGate 60F

The most comprehensive security measures we've seen in an SMB-level appliance, but the X factor is Fortinet's irreproachable remote-management features. **With 3yr UTP bundle, £1,753 exc VAT from avfirewalls.co.uk**
REVIEW Issue 319, p97

STORAGE APPLIANCES

Qnap TS-873A

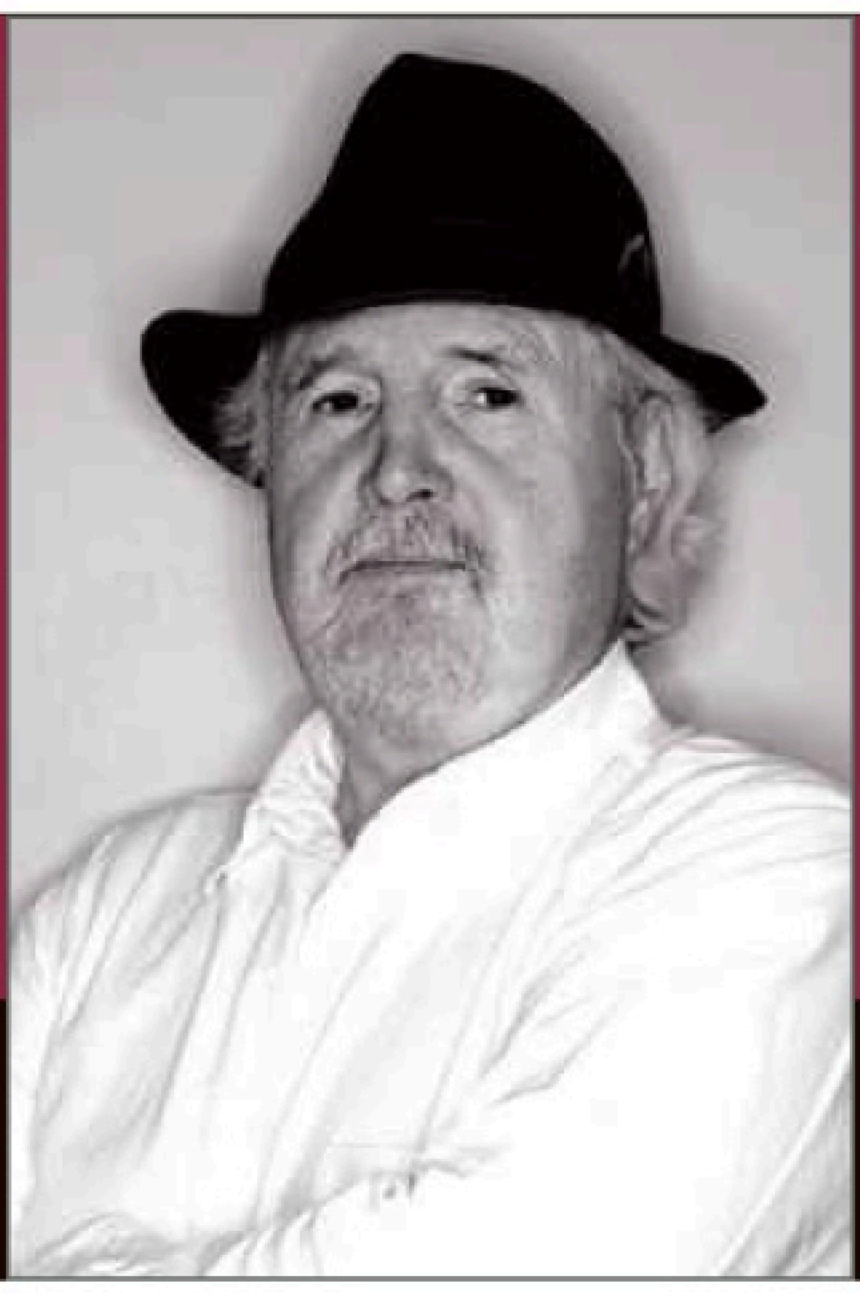
We'd still choose Qnap's nine-bay TS-h973AX if you want support for U.2 NVMe SSDs, but if not the eight-bay TS-873A is a flexible alternative – right down to the choice of two OSes. Both perform well and its dual PCIe slots offer great expansion potential. **Diskless/8GB, £886 exc VAT from broadbandbuyer.com**
REVIEW Issue 323, p100

Qsan XCubeNAS XN7016R

Growing SMEs that want enterprise-class data protection, great backup features and enormous expansion potential will find the XCubeNAS a solid choice. **Diskless, £3,565 exc VAT from ballicom.co.uk**
REVIEW Issue 321, p97

Grandpa's Axe applies to hi-fi systems, too

After the central element of his separates system goes pfft, Dick discovers a low-energy box that operates in the space between analogue and digital



Dick Pountain is editorial fellow of *PC Pro*. He thought DAC was a brand of trousers until he discovered Smirnoff. Email dick@dickpountain.co.uk

Grandpa's Axe is a figment of American folk mythology: "had it nigh on 60 years, never give me no trouble exceptin' fer two new heads and three new handles". My hi-fi system is very much like that. I'm far from being a hi-fi buff, but I listen to a lot of music and enjoy good sound. I bought an ex-review Sansui system back in the days when *Hi-Fi Choice* was one of *PC Pro*'s sister publications, but the only component remaining from that is a pair of wood-cased Castle speakers.

I still love those speakers. Nowadays all my audio feeds – smart TV, Spotify and YouTube on Chromebook, Sony CD player and Dunlop vinyl turntable – play through them. However, just before Christmas my latest amplifier, a Denon that also acted as the hub, expired with a horrid death rattle. Not being up to diagnosing and repairing it, I went online to look for a replacement.

Sadly, it appears "separates" hi-fi amps are a dying breed, and thus subject to Veblen pricing as rich folks' toys. Instead, I became intrigued by the new breed of tiny power amps meant for bookshelf systems, and found myself buying a Fosi bt20a. When I first unpacked it I thought it was a joke, not much bigger than a pack of cigarettes, but then I plugged it in and reeled in amazement as it drove my massive speakers just as loud, and with superior, more open sound quality than the Denon.

This isn't an audiophile magazine, so how can I steer this miracle around toward my digital brief? I assumed the Fosi must be digital inside, but I was wrong; it's even more interesting than that. It's a class-D device, technology that exists in a grey area between analogue and digital I've covered here before – for example, in the silicon retina chips designed by Carver Mead or AI chips that use analogue adders to perform convolutions. Hybrid analogue-digital circuits can often be fast and power-efficient as they don't need to analogue-to-digital convert their inputs and then digital-to-analogue convert the outputs. The price is loss of digital precision, but for some non-numerical applications that may be worth paying.

Class-D amplifiers are a nice case in point. They work by chopping up an analogue input signal into a high-frequency stream of square-wave pulses whose *spacing* represents the analogue values at each tiny interval. This stream then switches twin output transistors at a similarly high frequency, then filters out frequencies beyond the audible to directly produce an amplified analogue output signal. This process can be 70-90% efficient: because the two output transistors are never both on at the same time, little current flows and little power is lost as heat. The Fosi uses a phone-style 24V power supply and barely gets warm even when playing loud. It's still a wholly analogue technology as no bits are involved, but like a digital technology it works on a stream of discrete pulses, and can therefore be supported by cheap, miniature digital chips.

The efficiency and power saving such hybrid processing confers is becoming ever more desirable to designers of the neural networks on which deep learning AI depends. Implementing a simulated neural network in digital technology is hugely power hungry. Training a network involves storing billions or trillions of weights in memory cells, and then performing multiply-accumulate operations on them and new inputs when the network is used to analyse new data.

> **"I thought it was a joke, not much bigger than a pack of cigarettes, but then I plugged it in and reeled in amazement"**

> **"It's still a wholly analogue technology as no bits are involved, but like a digital technology it works on a stream of discrete pulses"**

In issue 301, I described how the US firm Mythic's IPU chip contains an analogue computing array of memory cells that are tunable resistors: computation occurs in place as each input voltage gets turned into an output current according to Ohm's Law, with resistance representing the stored weight value. With data and computation located in the same place, less energy is wasted and less silicon real estate is needed for A-to-D conversion. Similarly, Carver Mead's silicon retina chip employed an array of photosensitive cells connected by a network of resistors, with Kirchoff's Laws achieving the necessary "computation" as currents flow between them to achieve behaviour similar to that of the human eye.

Fitted with its second new head and third new handle, my audio environment is now immensely satisfying, even if it is so hybrid that it would cause a real audiophile to grind their teeth. The little black box omnivorously devours analogue feeds from TV, CD player and turntable (through an equally tiny analogue mixer) just as effectively as Bluetooth from my Chromebook. And it passes my own very analogue test regime: Wayne Shorter's *Footprints Live!* album makes my remaining hair stand on end via either route.

dick@dickpountain.co.uk

Time-travel to the early web with Wordle

Nicole Kobie is *PC Pro*'s Future's editor. She's yet to miss a word on Wordle, but has deleted Scrabble from her phone – and not just because she got tired of losing so brutally to editor Tim Danton.
@njkobie

Wordle shows the best of the web thanks to its stripped-down approach. It's only a shame it also shows the worst in us

My awareness of Wordle began how it likely did for many: friends sharing odd little blocky charts with scores out of six on Twitter and Instagram. As a fan of word games – readers may recall my rant about the terrible reboot of the bewilderingly flashy Scrabble app – I was naturally intrigued.

So I headed to Google, and searched for Wordle. The first result was an obscure-sounding website, **powerlanguage.co.uk/wordle**, the boring URL that hosts Josh Wardle's viral game, in which players have six chances to guess a five-letter word.

Visiting his website is like time-travelling to the early days of the web. Not because the website is basic, although it is. Players are greeted by an overlay with instructions, and the game itself is nothing other than a five-by-six grid and keyboard. When you've won or lost the day's challenge, a popup offers to share your results to social media – the blocky charts we all keep seeing.

Simple though Wordle is, what's retro about the game is what Wardle has left out. It's a website, not an app requiring a download. There's no data-hoovering login or registration. And there's no advertising or other way of monetising the game. It's made for no purpose other than fun. Just like the early days of the internet.

Back then the web was about sharing information. After all, it was largely built by and for academics. Google's mission statement was to "organise the world's information and make it universally accessible". When the rest of us got involved we bulked it out with hobby sites and personal blogs, most of which were designed to share with friends or build community, rather than make money.

That web is all but gone. It's no longer a digital space for sharing information, but an ecommerce and marketing platform. Does anyone believe that Google's main goal remains organising information rather than selling ads? Or consider Instagram: created for sharing photos with friends, its current purpose is predominantly consuming marketing content from brands and influencers.

There's still good information online, but you'll be haunted by ads shilling related topics whatever you search. But in Wordle, Josh Wardle has eschewed money for old-fashioned passion. The software engineer built the game as a gift for his crossword-loving partner when they were bored during lockdown, eventually sharing it with friends and family. According to the *New York Times*, in November 2020 the game had 90 players. At the time of writing, 2 million people visit every day.

Plenty of apps and sites have more users, and the letter-guessing format isn't new. So why has Wordle become so beloved? Wardle thinks he knows. "I think people kind of appreciate that there's this thing online that's just fun," he told the *New York Times*. "It's not trying to do anything shady with your data or your eyeballs. It's just a game that's fun."

But while Wordle harks back to the early web, it lives in the here and now of aggressive digital capitalism. Wardle isn't leveraging the success of his gift to his partner by doing anything shady, but others are. As soon as the game went viral, developers built app versions of Wordle, copying not only the game play – which isn't new – but also the name, dumping it into mobile markets. One sought to make a quick buck by charging $30 for a "pro" version with unlimited daily plays, instead of the single daily challenge. According to that developer's Twitter feed, his cloned app was downloaded more than 5,000 times an hour.

> **"There's no data-hoovering login or registration. And there's no advertising or other way of monetising the game"**

> **"As soon as the game went viral, developers swiftly built app versions of Wordle, copying not only the game play, but also the name"**

The copycat apps are no surprise, as whenever anything gets attention online, chancers race to monetise the zeitgeist. When a meme takes off, for example, it will be mere hours before news sites proffer up SEO-loaded explainer articles, YouTube is flooded with ad-ringed response and reaction videos, and Etsy and RedBubble creators start selling T-shirts.

And fair enough, people have bills to pay. But well done to Wardle for withstanding temptation and building a bit of old-school internet, reminding us what we've lost through the curse of monetising and data harvesting. This is the web we could have had, before it sold out.

App developers should learn from Wardle's example, rather than follow the lead of the copycats or even the rebooted Scrabble, which drowns the beloved game in weird animations, bewildering challenge formats and childish digital collectibles. People who like simple word games don't want such flashy complications – they just want simple word games. Hopefully, the success of retro Wordle inspires a better future for online and app development.

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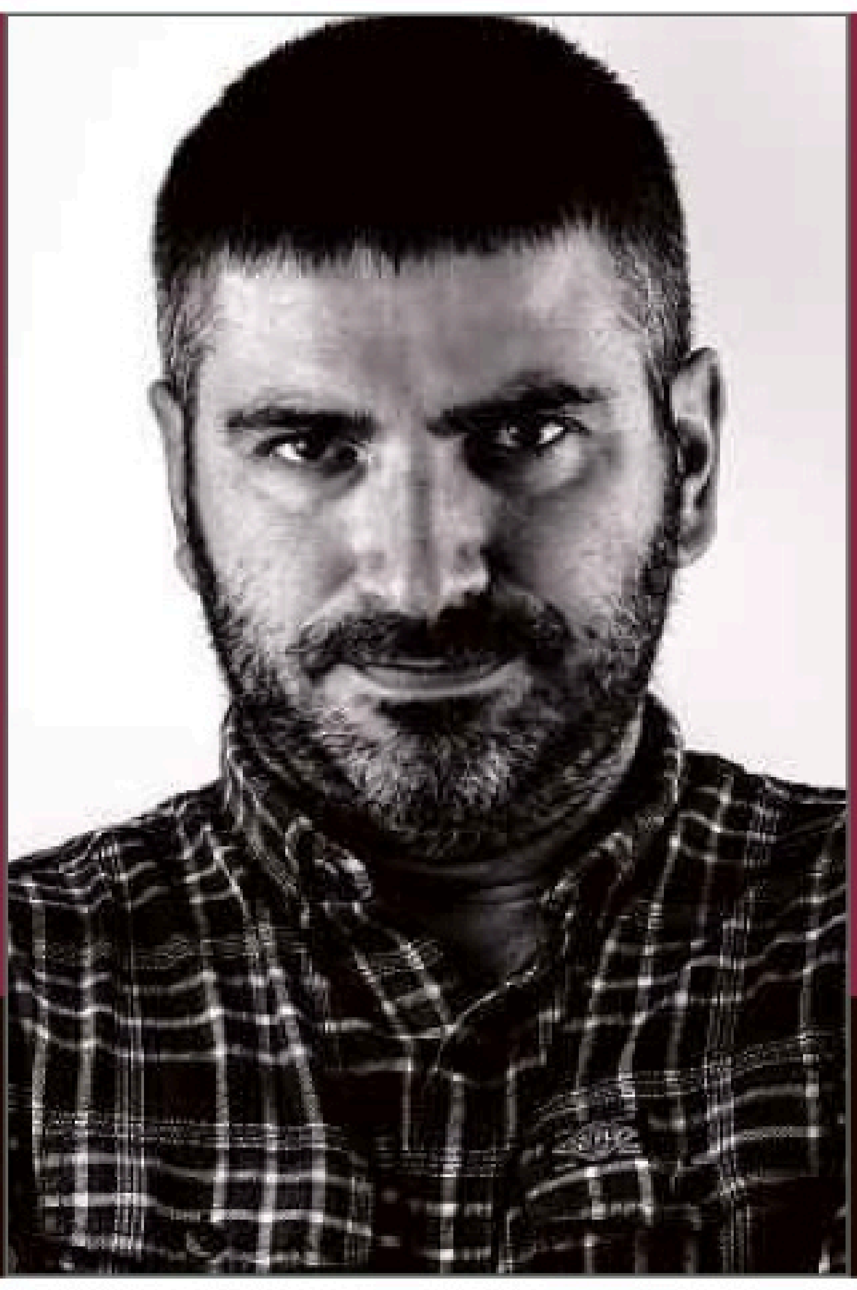
No more licence to print money

Chip shortages mean printer manufacturers' tricks are coming back to haunt them, but it's bad business even in the best of times



Barry Collins is the co-editor of BigTechQuestion.com. Ironically, he'll be printing the letters from Canon's lawyers when they read this.
@bazzacollins

Few phrases cause my blood to run colder than the beer in the fridge than when one of the kids yelps: "Dad, can I print my homework?"

Let me tell you something about kids. If they manage to leave a single square centimetre of white paper peeping through a sheet of A4, they consider it a personal failure. If the page doesn't emerge from the printer so sopping wet with ink that it needs 20 minutes on Gas Mark 4 to dry, they go back and try again. Even if the homework is nothing more than a six-syllable haiku, they'll print it in a 256-point font with a full-bleed bright-pink background, just to make sure they get top marks for presentation – and I need a payday loan just to meet the ink bills.

The Pulitzer Prize judges won't be hoisting me on their shoulders for revealing that a thimble of ink in an official cartridge costs more than a weekend break to Dubai. Nor is *Panorama* begging me to break the story that branded ink cartridges are fitted with chips to prevent cheaper compatibles being used instead. The entire printer industry has been getting away with this heist for years. Until now, that is.

Canon recently came unstuck when the ongoing chip shortage meant that it couldn't source enough chips for the consumables in some of its business-grade printers (*see Canon's explanation on p24*). To stop printers running dry, Canon started making official cartridges without the security chips, but that led to customers being plagued with pop-up warnings that they were using knock-off cartridges.

Canon was thus obliged to issue workarounds on its website, explaining to customers how they could bypass the warnings and continue using the unchipped toner they'd bought. A crap experience for customers, who've paid for official inks but have to wade through warning screens every time they want to print something. And a crap day for Canon, which has almost certainly just revealed how to avoid having to buy its official inks ever again – albeit at the expense of laboriously wading through a series of pop-up warnings. Insert your own phrase about roosting chickens here.

Just to add to Canon's problems, the company is currently facing a lawsuit in the US (where else?) over the way it allegedly cripples the scanner on some multifunction devices when the printer runs out of ink. "Canon does not represent or warn consumers that ink is a necessary component in order to scan or fax documents," the lawsuit claims. "As a result, consumers are forced to incur unexpected and unnecessary burden and expense in the form of ink purchases or in the alternative be unable to scan or fax documents using the so-called all-in-one device." Full marks for the use of "so-called" there.

As first spotted by Techdirt, Canon's own customer support representatives have confirmed as much on the company's support forums. "The PIXMA MG6320 must have all ink tanks installed in the printer and they must all contain ink in order to use the functions of the printer," a representative wrote when a customer complained they couldn't scan when the ink was empty (**pcpro.link/330canon**). "Replacing the empty ink tank with a new ink tank will resolve this issue. There is no workaround for this."

> **"If kids manage to leave a single square centimetre of white paper peeping through a sheet of A4, they consider it a personal failure"**

> **"The printer industry has got away with treating us like mugs for too long. Disabling devices is not a sustainable business model"**

Canon is by no means the only printer company to pull such stunts. I remember coming close to launching an HP printer out of a first-floor window when it refused to print monochrome documents just because the colour cartridge had run dry. I'm sure other manufacturers are equally culpable.

The moral of this tawdry little tale? Designing products to actively work against your customer is a terrible idea. If you can't convince customers to buy your official inks on the basis of their superior quality, don't take their device hostage when they decide to shop elsewhere. If a customer – for whatever reason – has run out of ink, don't disable the bits of the machine that don't need it.

This is not Steve Jobs-grade business insight. It is sense so common that Danny Dyer would be cast to play it in the movie.

The printer industry has got away with treating us like (checks the Danny Dyer Thesaurus) mugs for too long. Disabling devices is not a sustainable business model.

I'll print that last line out and send it to Canon. In fact, I'll get my kids to do it, so that Canon doesn't miss it. Can anyone lend me £50 for the ink?

barry@mediabc.co.uk

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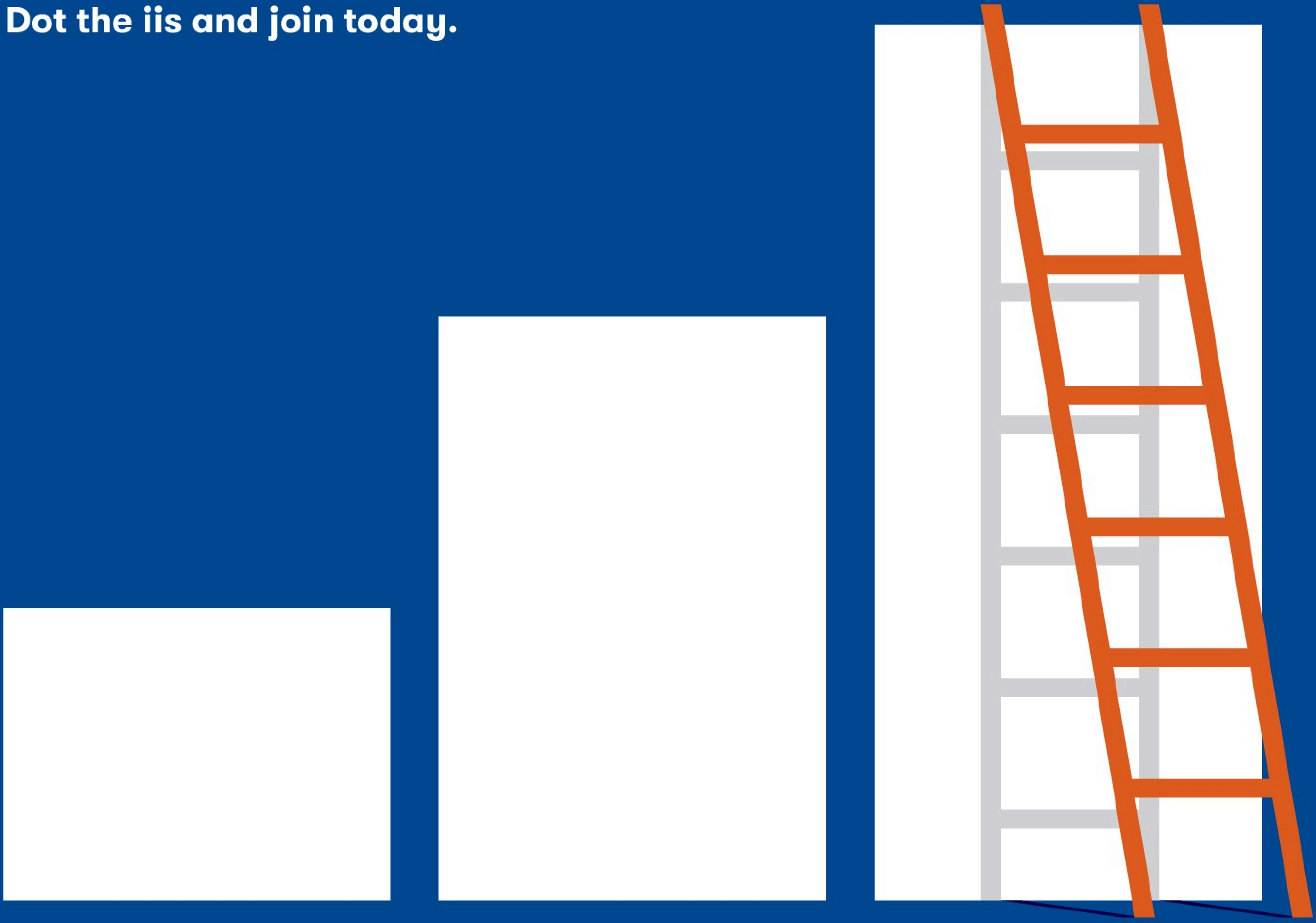

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Readers' comments

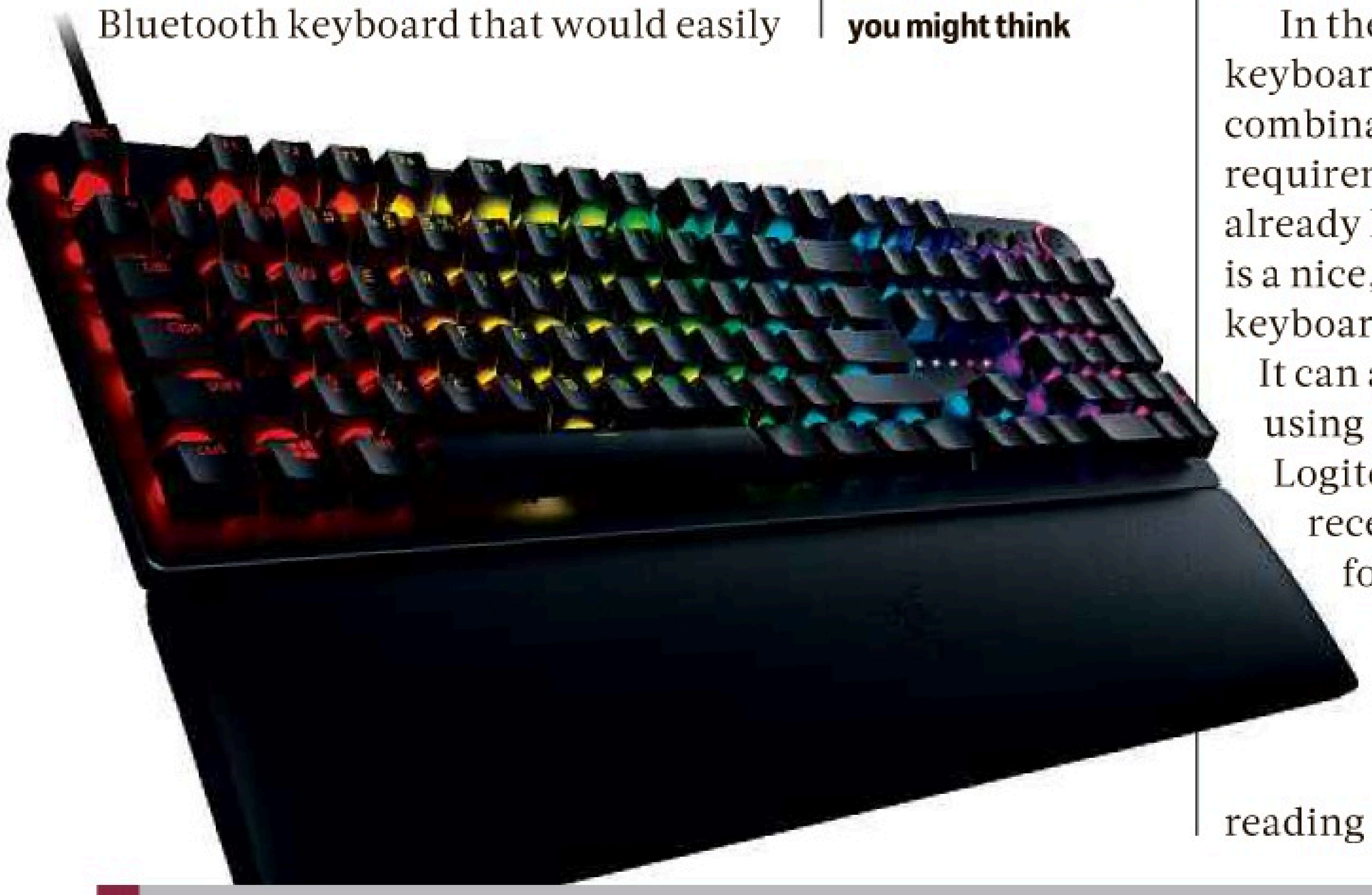
Your views and feedback from email and the web

Key keyboard factor

I found your article on keyboards (*see issue 329, p36*) fascinating; I had no idea there was quite so much variation in keyboard design. For me, though, it left out one important factor: can I even get the keyboard I want?

Up until the start of lockdown I'd muddled along with two keyboards in my home office: a Logitech illuminated wired keyboard for my desktop computer and a cheap cordless one for when I had my work laptop at home (using the same desk and screens).

Once my work laptop became a semi-permanent fixture, this became somewhat inconvenient. I decided that the best option would be a Bluetooth keyboard that would easily switch between the two computers. As a programmer who makes heavy use of the backslash key, though, I wanted to be able to access that without having to use a special key combination, and I also wanted separate cursor keys and ideally a number pad as well. You'd be surprised to find how hard it is to match those requirements, as most Bluetooth keyboards don't seem to have a separate backslash key.



BELOW Finding the perfect keyboard can be trickier than you might think

I tried out a cheap keyboard from Amazon that met all the requirements except that the backslash and pipe symbols were accessed using a function key, but even after a couple of months of heavy usage I just couldn't get along with it.

In the end I found a Logitech K850 keyboard and M720 mouse combination that met all my requirements – a bit of a shame as I already had a M720 mouse. The K810 is a nice, solid semi-ergonomic keyboard with a decent feel to it. It can attach up to three devices using either Bluetooth or a Logitech unifying wireless receiver, so I can use Bluetooth for the office and home laptops and the wireless receiver for my desktop computer (likewise for the mouse).

Out of curiosity, after reading the article, I looked through the keyboards offered by Razer and Das Keyboard and found that none of them met my needs. **John Gwatkin-Williams**

In bed with Microsoft?

In common with most technical journalists, Darien Graham-Smith endorses Microsoft FUD by implying that the Windows 11 requirement for TPM 2 and for a recent processor are two separate things (*see issue 329, p26*). As far as I can determine, most recent AMD and Intel processors include TPM 2 within the chip. I think there are probably few, if any, machines that would pass the processor requirement but fail on missing TPM.

The fly in this ointment is that for some obscure reason, most BIOS settings for desktop motherboards disable TPM by default. Before giving up on Windows 11, or hacking the Registry to force-install it, it's well worth poking about in your BIOS settings to see if TPM 2 can be enabled on the hardware you already own!

I was only saved from an unnecessary purchase of a TPM module by the fact that, under pressure of Covid supply chain shortages and Microsoft-stimulated excess demand, they are currently impossible to obtain! **John Hind**

Associate editor Darien Graham-Smith replies: It's true, Windows 11 only supports CPUs with native TPM 2 capabilities – so if the installer complains that you don't have a compatible TPM chip, it's probably just disabled in the BIOS. You can normally fix this by toggling a single setting, but note that on some Intel motherboards the function you need might be referred to as PTT (Platform Trust Technology), while AMD boards may call it PSP (Platform Security Processor). Look out for a detailed guide to TPM in next month's *PC Pro*.

Canon statement on global chip shortage

Barry Collins takes aim at chips in printers in his Viewpoints column this month (*see p22*), and mentions Canon by name. We felt it was only fair to give Canon the right to reply. It declined to comment on the active lawsuit that Barry mentions for legal reasons, but had this response about the chips in its toner cartridges:

"Whilst the global shortage of semiconductor components continues to affect many industries, it's our priority to prevent any disruption to our customers. As with all manufacturers, we continually monitor our supply chain to anticipate and prepare for any potential disruption and we are taking steps to deal with the situation, such as adjusting product designs.

"One example of this is in toner bottles for our MFP range as we are currently facing a shortage of the chip that is fitted inside the bottle to monitor its remaining ink levels. There is no shortage of toner itself – just of a chip that lies inside the bottle. As such, we're now shipping toner bottles for some of our MFP range without this chip to ensure we're still providing a continuous supply of consumables to our EMEA customers.

"We have issued some temporary guidance on how to install and manage these new bottles and will soon release a firmware update which will allow our chipless toners to be configured automatically, avoiding the need for manual intervention by our customers.

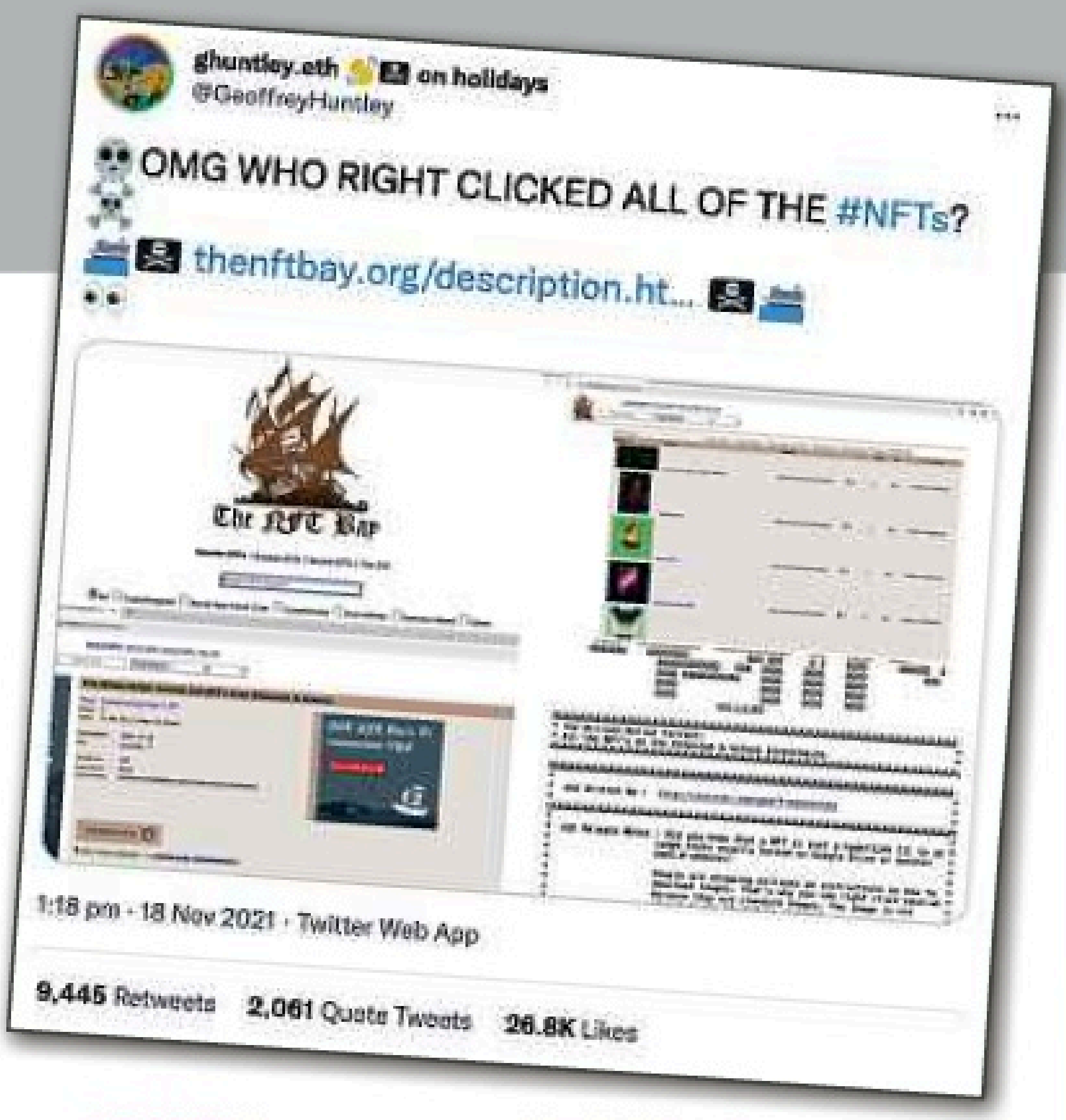
"We would like to clarify that the interim solution that Canon has implemented has limited impact. It only applies to the toner bottles for certain multifunctional printers in our imageRUNNER and imageRUNNER ADVANCE series, which are used exclusively by our corporate and business customers. There is no change to our inkjet cartridges, therefore there is no impact for consumers."

Torrent of NFTs

Can I be the 94th person to point out that Geoff Huntley's "torrent of NFTs" is actually 17 terabytes in size, and not 17 gigabytes as your article states (*see issue 329, p11*)?

I'm not sure about the average *PC Pro* reader who might have taken a butcher's at the magnet link, but I certainly don't have either 17TB of disk space currently doing nothing, or sufficient available VDSL bandwidth to grab the contents in anything under a very long time indeed.

I had fun reading the Twitter comments at **pcpro.link/330nft**,



ghuntley.eth on holidays
@GeoffreyHuntley

OMG WHO RIGHT CLICKED ALL OF THE #NFTs?

thenftbay.org/description.ht...

1:18 pm · 18 Nov 2021 · Twitter Web App

9,445 Retweets 2,061 Quote Tweets 26.8K Likes

ABOVE See next month's *PC Pro* for our verdict on the NFT craze

mind. Lots of fungible fanboys having a mocking meltdown while missing the point. **Mark Studden**

Time portal

Please could you ask your distribution department to send me a copy of the *Financial Times* dated early March 2022? They clearly have a time portal to the future, as my March 2022 copy of *PC Pro* arrived on 6 January.

But seriously, why does *PC Pro* have such a bizarre cover dating policy? It really makes the magazine and its contributors appear very unprofessional. For example, Christmas gift ideas in February; New Year predictions in February; software downloads that expire before the cover date.

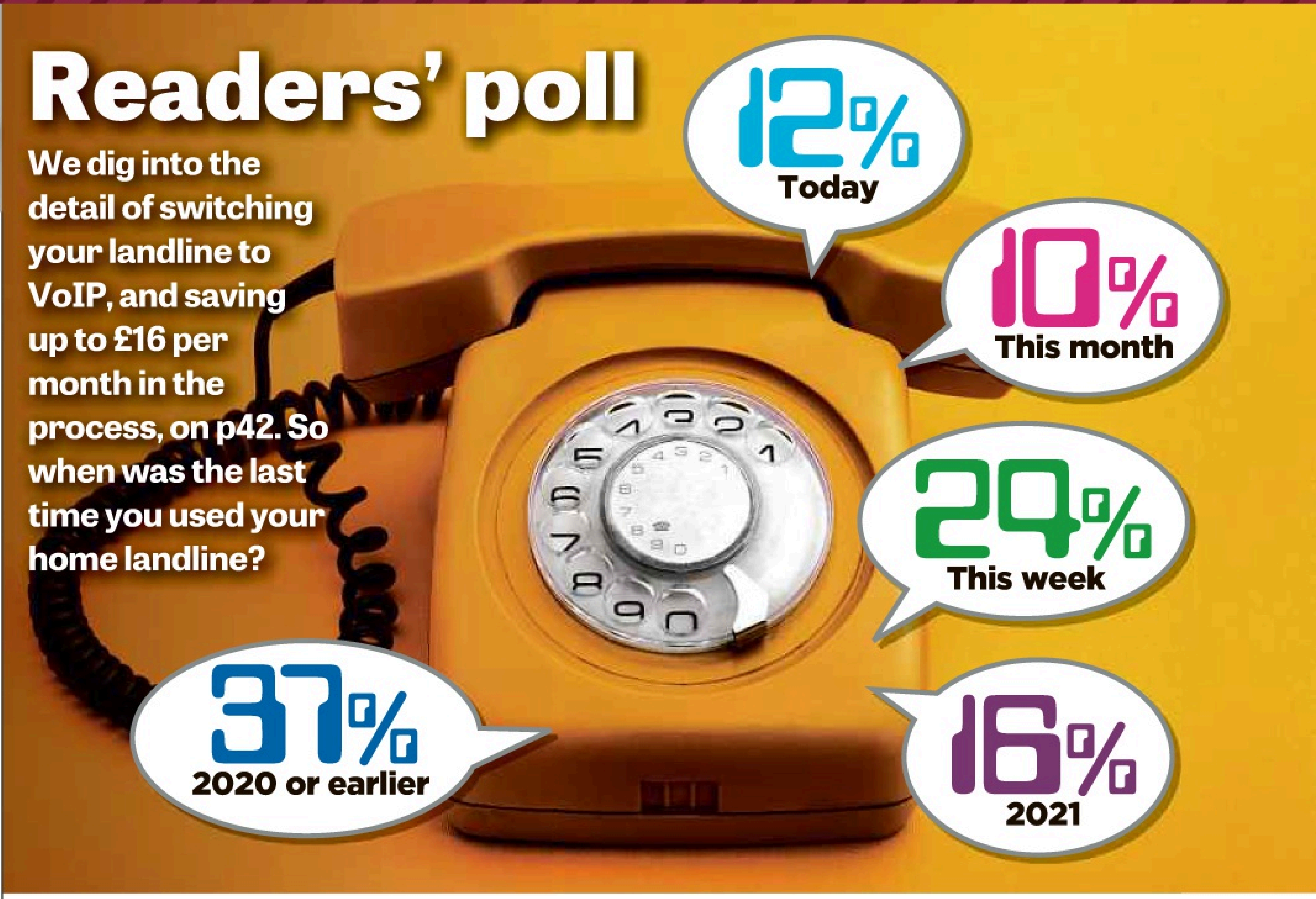
Apart from this gripe, you produce an excellent magazine. Your article on upgrading old laptops convinced me to buy the Kingston 1TB upgrade kit and fit it to a 12-year-old Toshiba Satellite. After using the Acronis cloning software, changing the drive took less than three minutes from picking up the screwdriver to Windows 10 opening! The laptop now runs Windows 10 with no problems and opens Word and Excel instantly. **David Hodgkinson**

Editor-in-chief Tim Danton replies: David, you win the prize for the most entertaining way to ask me this question, which lands in the *PC Pro* inbox every other month one way or another. The simple answer is that it's a legacy from the days of 20 computer magazines on the newsagent shelf, all vying with one another to appear the most current.

I have tried many times over the years to persuade *PC Pro*'s owners to make the cover dates more sensible, but never with success because the switch poses risks of confusion (both for our distributors and those readers who are now conditioned to expect the March issue in January!). However, I pledge to keep fighting the battle to change the date to something more realistic. Wish me luck!

Readers' poll

We dig into the detail of switching your landline to VoIP, and saving up to £16 per month in the process, on p42. So when was the last time you used your home landline?



We ran this poll in mid-to-late January, so feel pretty safe in declaring a 50/50 split: roughly half of us are still using landlines, but for the other half it's old hat. Maybe our article on p42 will shift even more people over the edge.

What also became clear from write-in responses was that ISPs are wrapping up the line rental into the terms of the broadband package. "Irrelevant," wrote Mobailey. "Can't buy a broadband/TV bundle without including line rental for a phone I'd forgotten I had."

Those who have been able to make the move, however, don't regret it. "We used ours so little that when the opportunity came for an FTTH without landline, we snatched it," wrote LadyBirdJB. "No landline at all, savings gone into really good broadband – not a very exciting or innovative idea, but it keeps me happy."

What we really wanted to know, though, was what you'd do with the savings:

"A second mobile phone to call the first (as that's what I used the landline for)." **James Arthur**

"Faster broadband. I only use my landline because a few older family members still call me on it." **Emma**

"Chocolate and biscuits." **Pam Newton**

"I would use it for altruistic good, of course. Well, funding impoverished wine makers anyway." **Skip**

"The BBC can have it." **Ben L**

"I will save up and in ten years visit Disneyland for the day." **MaXsEnDq**

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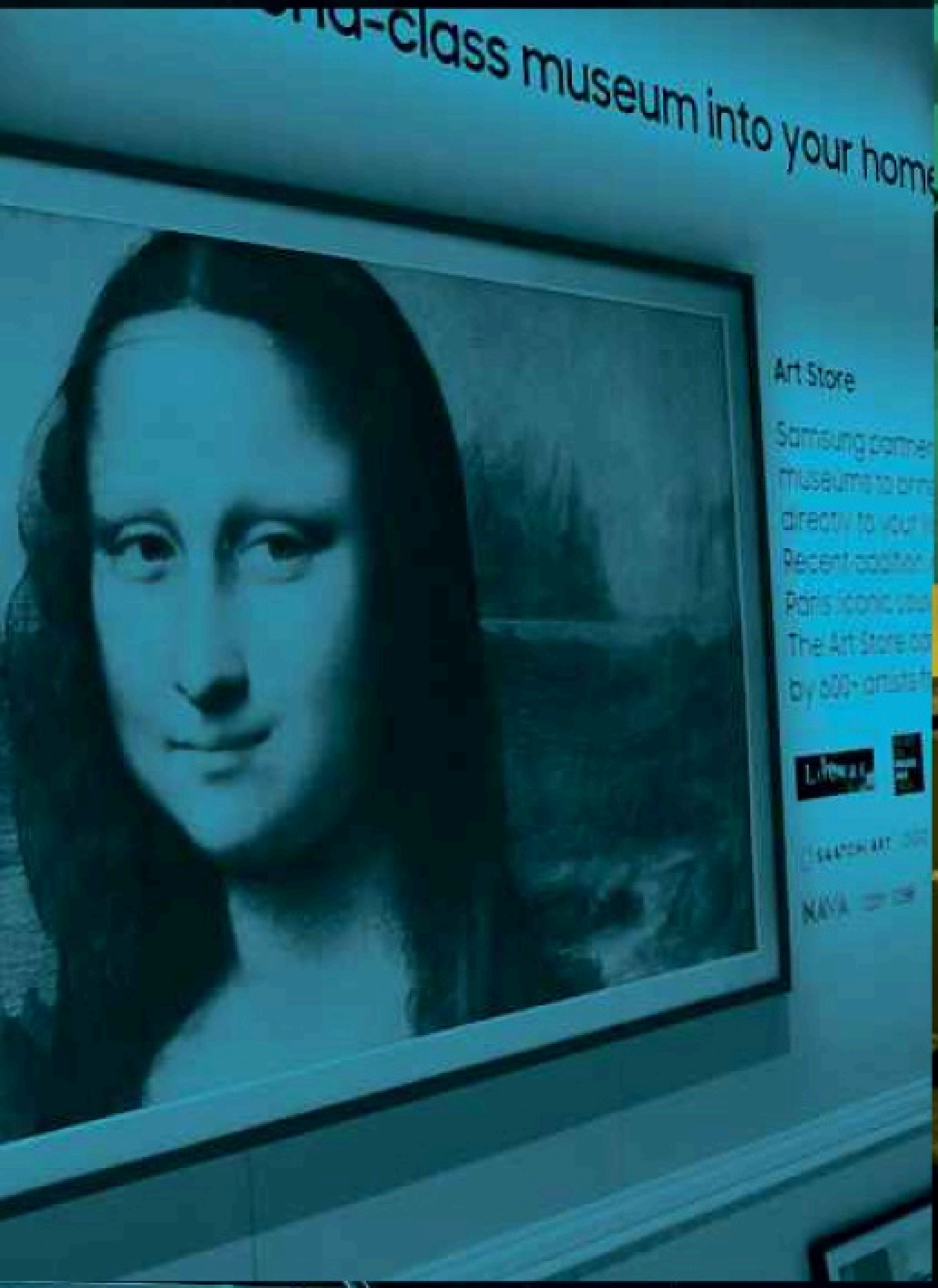
Digital Chassis
$13B
design win pipe

BEST OF CES 2022

Our picks from the physical show in Vegas along with the key virtual announcements

CONTRIBUTORS Tim Danton in Las Vegas, plus Barry Collins, Darien Graham-Smith and Jon Honeyball from the safety of their own homes

Snapdragon Digital
driving connected
intelligent



EUREKA PARK
60600 aisle
Choose France
La FRENCH TECH
Choose France
We hyb

Halls heaving with so many bodies you could barely walk a foot without jostling someone. LG's stunning waterfall of screens. Taxi horns blaring in frustration as they attempted to transport attendees from one venue to another, only to be met by the ever-lasting traffic jam from hell.

That was CES 2020. Roll forward two years and things couldn't have been more different. Halls with yawning gaps where exhibitors were meant to be. LG's stand a hollow echo of what came before, with makeshift signs that encouraged you to download an AR app to admire highlights from previous years. A taxi journey that previously took an hour now took eight minutes.

But there was life if you knew where to find it. Eureka Park, CES's home for startups and niche ideas, was buzzing: from the moment it opened, this is where many of the 40,000 attendees, a quarter of 2020's number, headed in search of the next big thing.

Meanwhile, the likes of AMD, Asus, Dell, HP, Intel and Lenovo cancelled their in-person appearances in favour of virtual launches. They still used CES as the springboard, but it was all look and no touch.

And some companies were just as present as before: Qualcomm, Razer and Samsung all took to the stage in one form or other.

It was a strange show, but there was much to admire from this year's CES. Over the coming pages, we pick out our favourite launches – and a number of curios.

→

PC PRO ★ BEST OF CES 2022 ★

LAPTOPS

Acer Swift X 14

Compared to the other laptops we've highlighted here, the Swift X 14 is rather, well, boring. Just a plain old 14in laptop with a choice of red or green lids. Move on, nothing to see.

But we think it's a sign of Acer shifting its sights towards more demanding buyers without the cost creep that can afflict the likes of Dell and HP. It's an all-metal chassis, but still weighs a reasonable 1.4kg, and copper heat pipes mean Acer can include GeForce RTX 3050 Ti graphics to accompany the 12th gen Core U series (*see p30*).

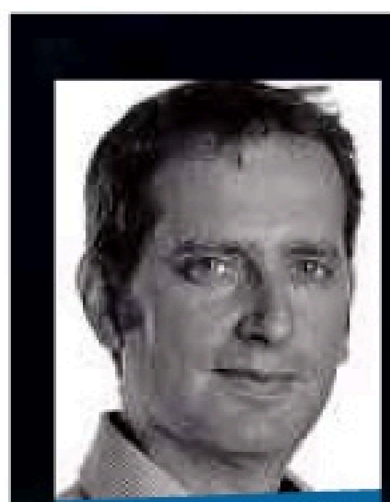
It's reassuring to see a screen that covers 100% of the sRGB gamut too, and a 2,240 x 1,400 resolution is tough to criticise. Acer even promises high-quality images in low light from the webcam. We won't have long to wait to see if it lives up to its claims, with the Swift X 14 available from "late Feb/ March" from £999.

Asus ZenBook 14X OLED Space Edition

This is an object of true geek beauty. Created to celebrate the 25-year anniversary of an Asus laptop's 600-day trip on the Mir station, this special edition of the ZenBook 14X lives up to the spirit of the original by meeting American SMC-S-016A space systems protocols – four times tougher than boring old military MIL-STD-810 standards. It even operates between -24°C and 61°C.

Then there's its design, with a special "Zero-G titanium" colour supplemented by a 3.5in OLED display on the lid to show off messages and animations of your choosing. Naturally, it's also packed with luxury: 12th gen Core chips, up to 32GB of RAM, Wi-Fi 6E and a 14in 2,880 x 1,800 OLED display. Prices start at £1,600 and the countdown to launch has already begun: lift-off is set for April.

SPACE EDITION
SPACE EDITION



TIM'S PICK OF CES

Asus ZenBook 17 Fold OLED

I hesitate to even put the ZenBook 17 Fold OLED into a category, as this is a "laptop" that transcends the usual computing norms. It's a 17in all-in-one PC. A gigantic 1.6kg tablet. A two-screen ebook reader. But also, by bending the screen in half and placing the bundled Bluetooth keyboard across the lower portion, a 12.5in laptop. The world needs a super-word that goes beyond "versatile" to describe this extraordinary piece of technology.

But let's snap back to reality for a moment. Asus hasn't yet announced a price or a release date, nor have I managed to lay my hands on the product. That's crucial, because the success of the ZenBook 17 Fold will live or die by the quality of its engineering. For a start, if it's a great PC to use – and the integrated stand and Core i7 U Series chips (*see p30*) suggest that it could be – then it has a chance.

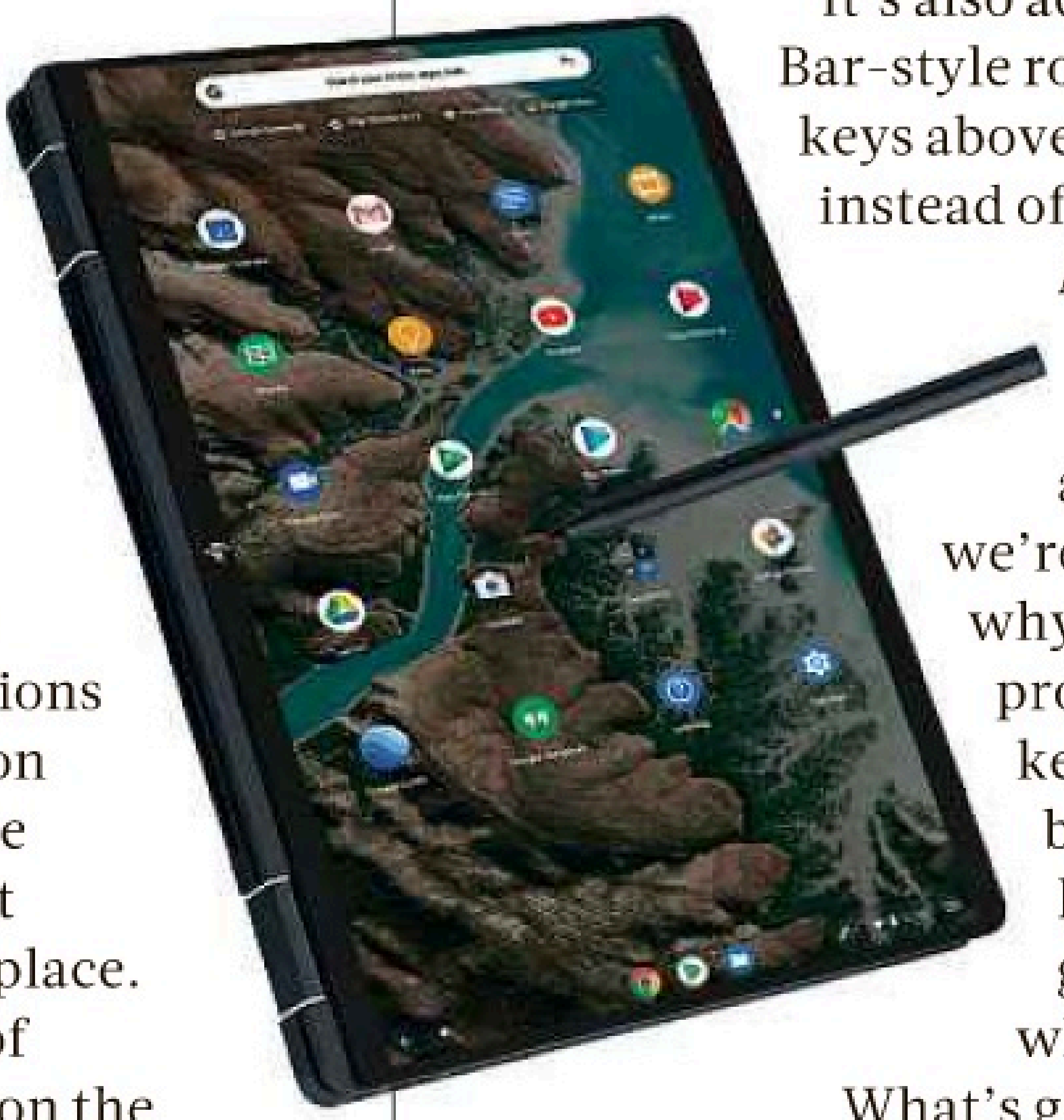
Then you also need to take advantage of its tablet features. How usable will it be? Unfolded, it's 379 x 288 x 12mm, so you won't be holding it in a single hand. You'll need it to be sturdy enough to take on your travels and have strong battery life (it includes a respectable 75Wh battery). Perhaps most of all, you need Windows 11 to work equally well in all modes.

I'm confident the screen will be a strong point. As its name gives away, this is based on OLED technology, and Asus promises 100% coverage of the DCI-P3 colour gamut. Even the 5MP webcam and quad speakers sound promising.

Am I optimistic? That's too strong a word. What I do know is that Asus deserves plenty of praise for thinking so radically, and delivering on the promise – with a prototype at least. *PC Pro* will be first in the queue for review samples when it launches later this year.

HP Elite Dragonfly Chromebook Enterprise

HP updated its gorgeous Dragonfly for Windows at CES, with the G3 version hopefully fluttering its wings in the UK from March, but we were more intrigued by its new Chromebook incarnation. It has much in common with the Windows variant, including a 5MP webcam for (please!) high-quality video calls, along with a sub-1kg convertible chassis and 13.5in 3:2 touchscreen. Resolutions will vary depending on the models, as will the spec, but Intel's latest processors will be in place. It's yet another sign of Chrome OS's impact on the workplace, even if this model's as-yet unconfirmed price is likely to push it into an executive niche. It goes on sale in April.



Dell XPS 13 Plus

Top marks to Dell for attempting something different with the XPS 13 Plus. As for execution... we'll reserve judgement.

Really it should be called the Plus Negative, for where Dell giveth it also taketh away. Perhaps its most important addition is the 28W version of Intel's 12th generation Core processors, which will give this machine a boost over the regular CPUs in everyday tasks and gaming.

It's also added a weird Touch Bar-style row of capacitive keys above the main keyboard instead of function keys. Aside from the arguably improved aesthetics, though, we're not quite sure why, as you can't program them. The keyboard has also been stretched from left to right with no gap at the sides whatsoever.

What's gone? Most obviously, the trackpad. Instead, haptics and muscle memory will guide the user. And it's also trimmed the ports down to two Thunderbolt 4 USB-C connectors.

We don't yet have a price, but Dell says the XPS 13 Plus will go on sale in "spring 2022".

Lenovo ThinkBook Plus Gen 3

You can imagine the conversation. "It's a great design, team, a gorgeous 17.3in laptop. Love the 120Hz screen, the integrated digital pen, and Intel's new H Series chips. But there's just something missing."

"Number pad, boss?" "No need." "Lots of ports?" "USB-C, HDMI, Thunderbolt 4 and USB-A will do them just fine." "Boss? You'll think I'm crazy, but..." "Spit it out, son." "Well, how about we put in a second screen?" "On the back? E Ink? No, we've done that before." "No... I was thinking an 8in touchscreen display next to the keyboard. Stupid idea, I know."

Silence in the room. "Son, you're a genius." Turns to the engineers. "Get it done. Make sure it weighs less than 2kg and runs Windows 11 Pro. We'll worry about pricing later."

TCL Book 14 Go

TCL may not be the biggest of names in the UK, but the Chinese company had a big CES with numerous announcements across all its key areas. That included a bunch of 144Hz mini-LED TVs, education-focused tablets and a pair of lightweight AR spectacles (*see Weird & Wonderful, p34*).

It also sneaked out its first laptop, the TCL Book 14 Go. Built on Qualcomm's Snapdragon 7c platform, it's worth mentioning here that Qualcomm also took to the stage at CES to declare that the tide was turning towards Windows on ARM. We were in the room for that statement but remain unswayed. To paraphrase a movie, show us the laptops.

Still, the TCL Book 14 Go shows that slim, attractive and well-priced laptops can be built using Qualcomm's SoC, even if the 4GB of RAM, 128GB of storage and 1,366 x 768 14in display reflect the low $349 price. Where it wins is portability, with 12 hours of battery life, a 1.3kg weight and 14mm-thick frame.

PC PRO BEST OF CES 2022

DISPLAYS

Dell U3223QZ videoconferencing monitor

Dell proves that it's not only laptop screens that can have a webcam built in with the catchily named U3223QZ videoconferencing monitor. It's a 4K display with a 4K webcam attached, which uses the Sony HDR STARVIS CMOS to make you look your best on those tiresome Teams calls. (There's a dedicated Teams button on the front of the display if you get really tired of them and want to hang up.)

If you're worried that the camera won't put you bang in the middle of the frame, the camera tilts by 20°, and you can switch between three different fields of view to ensure you get as much or as little of your bookshelves in the background as you desire.

The screen itself is a 31.5in IPS panel that promises 98% coverage of the DCI-P3 gamut, so it should look distinctly punchy. There's a pair of built-in 14W speakers, too. It will be available from 29 March for an as-yet unannounced price.

LG DualUp Monitor

Pitched at content creators and coders alike, the DualUp (model 28MQ780) has an almost square 16:18 aspect ratio, which LG claims is a first for the monitor market. It's designed to act as two 21.5in displays wedged into one, with a resolution of 2,560 x 2,880.

It has a vertical split-view function, effectively allowing the PC to treat the single screen as two displays. This, LG claims, reduces the side-to-side neck movements required with two displays, which can be a cause of neck pain. The accompanying LG Ergo stand can be clamped to desks and tables both to save space and help you get the positioning just right.

There's no word on price, but we'll stick our necks out and say it's going to be punchy.

Samsung Freestyle portable projector

With TVs now as big as walls, projectors have largely stepped back into the shadows. Samsung's £999 Freestyle Projector literally puts a new spin on the technology, however.

The cylindrical, portable projector is designed to be used indoors and out, with Samsung positioning it as something you might use to watch films in the home or the garden. The company is also pitching it as a portable art installation, letting kids project images onto the streets. An adapter even lets you plug it into an E26 lightbulb socket to hang the projector from your ceiling.

The Freestyle weighs less than a kilogram, but there's no integrated battery if you do want a portable projector – that's an optional USB-C accessory, along with a waterproof case. At 550 lumens, it's not the brightest projector ever, but it's certainly different.

Sadly, it's also more expensive than we were hoping at £999, but if that doesn't put you off then pre-order at **pcpro.link/330free**. We expect it to go on sale in the coming weeks.

The Freestyle Skin

DISPLAYS (CONT)

Smart Monitor M8

Samsung Smart Monitor M8

We'll be honest: we walked right past this monitor when we visited Samsung's CES booth. Other than being slim at 11.4mm, and as a result substantially more stylish than your run-of-the-mill 32in display, it keeps its talents well hidden. Those include the smart TV apps built into its on-board OS, its ability to operate as a SmartThings control hub and a movable webcam that peeks out from the top of the monitor – but only if you look closely. Naturally it supports the main video-calling apps, so you can join those endless calls from the comfort of your sofa – or just hook up your laptop and use it as a monitor.

Samsung didn't sully the Smart Monitor M8's launch with details such as price or availability.

ViewSonic VP3286-4K OLED

This 32in 4K monitor is simply spectacular to behold. Almost as spectacular as the $5,000 ViewSonic is asking for it. But bear in mind that this display is aimed at professional users, particularly those who need to edit video and photos for maximum impact on OLED screens.

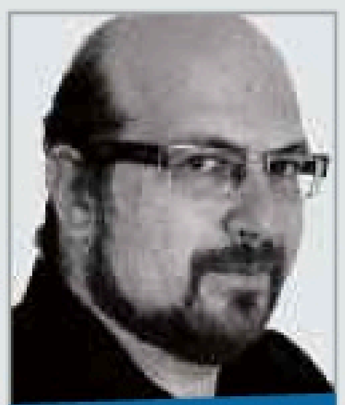
It's been given the green light for accuracy by both Adobe and Pantone, while a connected dial makes it ludicrously easy to switch between colour profiles. It's due out in Q2/Q3 this year, and based on our early encounter with it on the showfloor we'll be asking for a review sample as soon as it's available.

Samsung The Frame (2022)

The Frame isn't a computer monitor so technically shouldn't be in this *PC Pro* roundup, but it's so gorgeous that we can't resist mentioning it. The idea is simple enough: a TV with a stylish frame, complete with a licence to use some of the world's most famous paintings. So when the TV is off, it looks like a work of art hanging on your wall.

In this update, Samsung has switched from a glossy finish to matte, and the effect is truly stunning. We had to walk right up to the screen to see that it wasn't a genuine print.

2022 The Frame



DARIEN'S PICK OF CES

TP-Link Archer AXE200 Omni

I love Wi-Fi 6, and I'll probably love Wi-Fi 6E even more once I have a phone and laptop that support it. But that's the problem with the latest wireless standards; you have to update all your client devices to get the benefit.

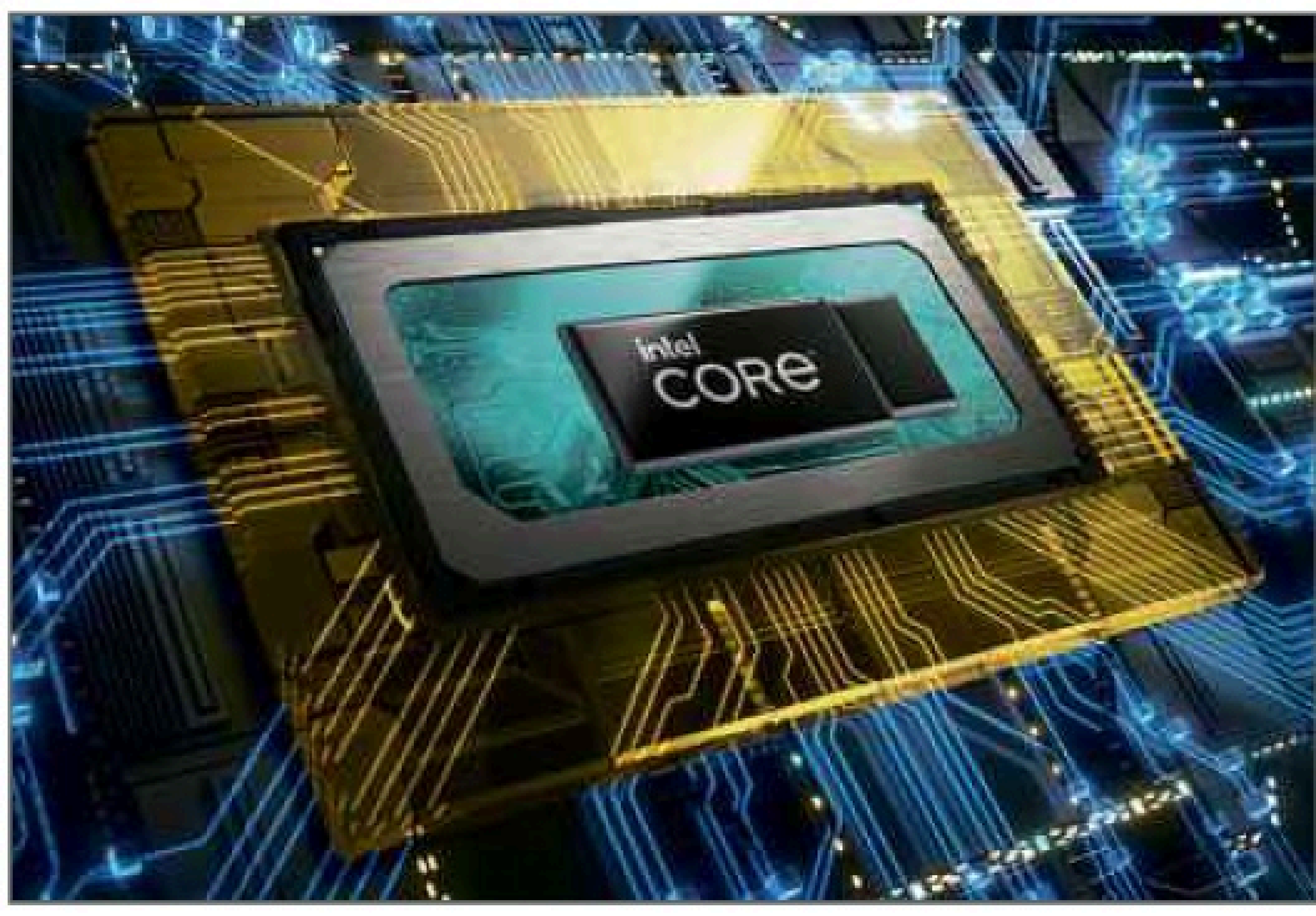
So I'm excited about TP-Link's Archer AXE200 Omni router. Not only is it one of the first Wi-Fi 6E routers out there, it's the first we've ever seen to sport mechanised aerials, which automatically rotate to optimise the radio signal to connected devices, no matter where they're located.

It may sound like a gimmick, but the positioning and orientation of your antenna can make a real difference to wireless performance. Naturally we'll have to test TP-Link's implementation to see how effective it is, and how it handles a modern household with smart devices spread out across multiple rooms. But I won't be surprised if performance gains of 20% are attainable, at least for some clients.

The great part is that a stronger signal benefits all devices, regardless of whether they're using the latest 6GHz connection or making do with an old 802.11n radio. This is sure to be an expensive router when it finally goes on sale (rumours are of a Q2 release), but if it can provide an instant speed boost to all your existing gadgets, it may well be worth the money.

SILICON

PC PRO BEST OF CES 2022



12th Gen Intel Core mobile processors

If you're already familiar with Intel's 12th generation Core processors for the desktop, then you won't be surprised by the mobile lineup's key feature: a combination of performance cores ("P cores") and efficiency cores ("E cores") that echoes the Big.Little architecture found in ARM designs.

Together with support for DDR5 memory and the fifth generation of PCI-Express, this new family of chips is being given the best chance to thrive. Intel is also integrating Wi-Fi 6E and support for Thunderbolt 4 into the package. Bottlenecks, what bottlenecks?

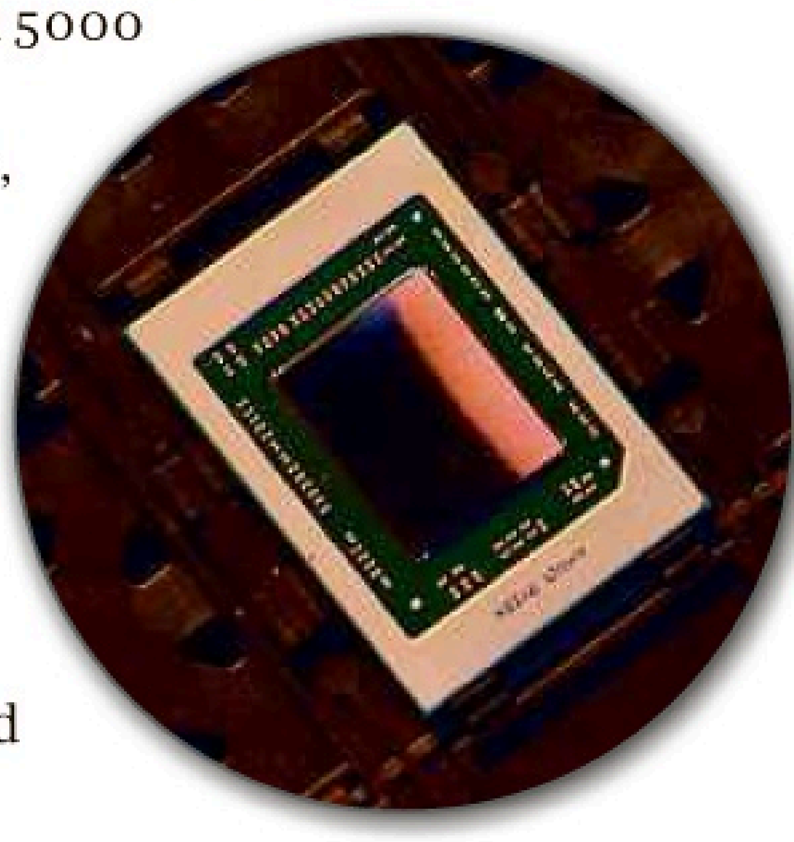
As ever, Intel complicates matters by splitting this generation of chips into three series. At the top, the H Series, where power efficiency takes a back seat to performance, so expect to see these processors in chunkier laptops aimed at creators and gamers. The U Series is designed for slimmer laptops, but split into two power categories: 15W for more power, 9W for more efficiency. And the P Series sits in the middle ground.

We provide a full breakdown of all the new 12th Generation mobile processors in the table opposite (top).

AMD Ryzen 6000 Series processors

AMD's confusing approach to naming processors continued at CES, where it announced the Ryzen 6000 series for laptops and the Ryzen 7000 series for desktops. And three Ryzen 5000 chips for mobile. And one Ryzen 5000 chip for desktops.

Let's focus on the 6000 series first. These are built on AMD's new Zen 3+ architecture, a more power-efficient version of Zen 3 found in existing Ryzen 5000 chips. They'll support DDR5 memory, PCI-E 4, Wi-Fi 6E and USB 4. We provide a full breakdown of all the announced chips opposite.



The other key addition to the Ryzen 6000 series is integrated Radeon 680M graphics

	H SERIES							P SERIES						U SERIES[2]				
	i9-12900H[1]	i7-12800H	i7-12700H	i7-12650H	i5-12600H	i5-12500H	i5-12450H	i7-1280P	i7-1270P	i7-1260P	i5-1250P	i5-1240P	i3-1220P	i7-1265U	i7-1255U	i5-1245U	i5-1235U	i3-1215U
Cores	14	14	14	10	12	12	8	14	12	12	12	12	10	10	10	10	10	6
Threads	20	20	20	16	16	16	12	20	16	16	16	16	12	12	12	12	12	8
L3 cache	24MB	24MB	24MB	24MB	18MB	18MB	12MB	24MB	18MB	18MB	12MB	12MB	12MB	12MB	12MB	12MB	12MB	10MB
Base power	45W	45W	45W	45W	45W	45W	45W	45W	45W	45W	45W	45W	45W	15W	15W	15W	15W	15W
Turbo power	115W	115W	115W	115W	95W	95W	95W	64W	64W	64W	64W	64W	64W	55W	55W	55W	55W	55W
P-CORES																		
Number of cores	6	6	6	6	4	4	4	6	4	4	4	4	2	2	2	2	2	2
Max Turbo frequency	5GHz	4.8GHz	4.7GHz	4.7GHz	4.5GHz	4.5GHz	4.4GHz	4.8GHz	4.8GHz	4.7GHz	4.4GHz	4.4GHz	4.4GHz	4.8GHz	4.7GHz	4.4GHz	4.4GHz	4.4GHz
Base frequency	2.5GHz	2.4GHz	2.3GHz	2.3GHz	2.7GHz	2.5GHz	2GHz	1.8GHz	2.2GHz	2.1GHz	1.7GHz	1.7GHz	1.5GHz	1.8GHz	1.7GHz	1.6GHz	1.3GHz	1.2GHz
E-CORES																		
Number of cores	8	8	8	4	8	8	4	8	8	8	8	8	8	8	8	8	8	4
Max Turbo frequency	3.8GHz	3.7GHz	3.5GHz	3.5GHz	3.3GHz	3.3GHz	3.3GHz	3.6GHz	3.5GHz	3.4GHz	3.3GHz	3.3GHz	3.3GHz	3.6GHz	3.5GHz	3.3GHz	3.3GHz	3.3GHz
Base frequency	1.8GHz	1.8GHz	1.7GHz	1.7GHz	2GHz	1.8GHz	1.5GHz	1.3GHz	1.6GHz	1.5GHz	1.2GHz	1.2GHz	1.1GHz	1.3GHz	1.2GHz	1.2GHz	900MHz	900MHz
GRAPHICS																		
Execution units	96	96	96	64	80	80	48	96	96	96	80	80	64	96	96	80	80	64
Max frequency	1.45GHz	1.4GHz	1.4GHz	1.4GHz	1.4GHz	1.3GHz	1.2GHz	1.45GHz	1.4GHz	1.4GHz	1.4GHz	1.3GHz	1.1GHz	1.25GHz	1.25GHz	1.2GHz	1.2GHz	1.1GHz

[1] The i9-12900HK has identical specs to the i9-12900H but is unlocked. [2] Intel is also producing a 9W version of the U series with lower base frequencies and lower peak frequencies for the graphics chips. Intel has also launched the Pentium 8505 and Celeron 7305 with 1P and 4E cores; the Celeron does not have Turbo abilities.

based on AMD's RDNA 2 architecture. That's a notable development for anyone who likes to game on the move, as AMD is promising superior performance to Intel's Iris Xe graphics and Nvidia's GeForce MX450 chip.

Later this year we'll also see Ryzen Pro versions of this family, with enhanced security features – including support for Microsoft's Pluton security processor, which is designed to supersede a separate TPM by building such protection into the CPU itself.

The three Ryzen 5000 chips stick with AMD's familiar (and modest) Vega graphics and are based on Zen 3 architecture rather than Zen 3+. We still expect them to pack a powerful punch.

AMD Ryzen 7 5800X3D desktop processor

Intel and AMD do like to have a barney over who builds the fastest gaming processor, and the 5800X3D is AMD's latest swing at the title. With an extra 64MB of cache – using AMD's 3D V-Cache technology as indicated by the chip's ugly name – games can access data much faster than before. The result, in AMD's own published benchmarks, is a 10 to 40% increase in frame rates at 1080p compared to its own Ryzen 9 5900X.

How does it compare to Intel's Core i9-12900K, widely considered to be the world's fastest gaming chip? According to AMD, it now ties its rival at 1080p in *CS:Go*, *Gears 5* and *Watch Dogs: Legion*, and beats it by 10% in *Far Cry 6* and *Shadow of the Tomb Raider*. We shall see.

AMD says the 5800X3D will go on sale in "spring 2022" but is keeping schtum on price.

AMD Ryzen 7000 series

Finally, AMD teased the arrival of its Ryzen 7000 desktop chips, set to land in the second half of 2022. These will all use the 3D V-Cache technology that debuts on the Ryzen 7 5800X3D, and to showcase its power AMD demoed *Halo Infinite* with all cores running at 5GHz. It wouldn't share the exact frame rates, but the 1080p demo looked suitably slick.

Built on 5nm Zen 4 technology (as opposed to the 6nm of Zen 3), the 7000 series chips will require a new motherboard chipset and AM5 LGA1718 socket. In return, AMD promises that the processors will be even more power-efficient.

There's a lot to look forward to in the coming months.

Intel Arc graphics

We have a good idea of what to expect from Intel's new mobile processors, but an air of mystery still surrounds its upcoming discrete graphics chip. Intel describes Arc as "high performance" but hasn't yet published benchmark figures, so we're reliant on leaks.

These suggest that the rumoured Arc A380, one of its lower-end offerings, will perform similarly to an Nvidia GeForce GTX 1650 card. We know the Arc A380 has 128 execution units, but Intel could create versions with 256, 384 or 512 EUs.

There are some things we know for sure. Arc supports hardware-accelerated ray tracing and Intel's "XeSS AI-driven upscaling technology", and it promises that "Deep Link technology harnesses the full power of the [Intel Core] platform". Intel also used CES to confirm that it has shipped the silicon to its partners for testing and that 50 products will ship with Arc, across laptops and desktops, in 2022.

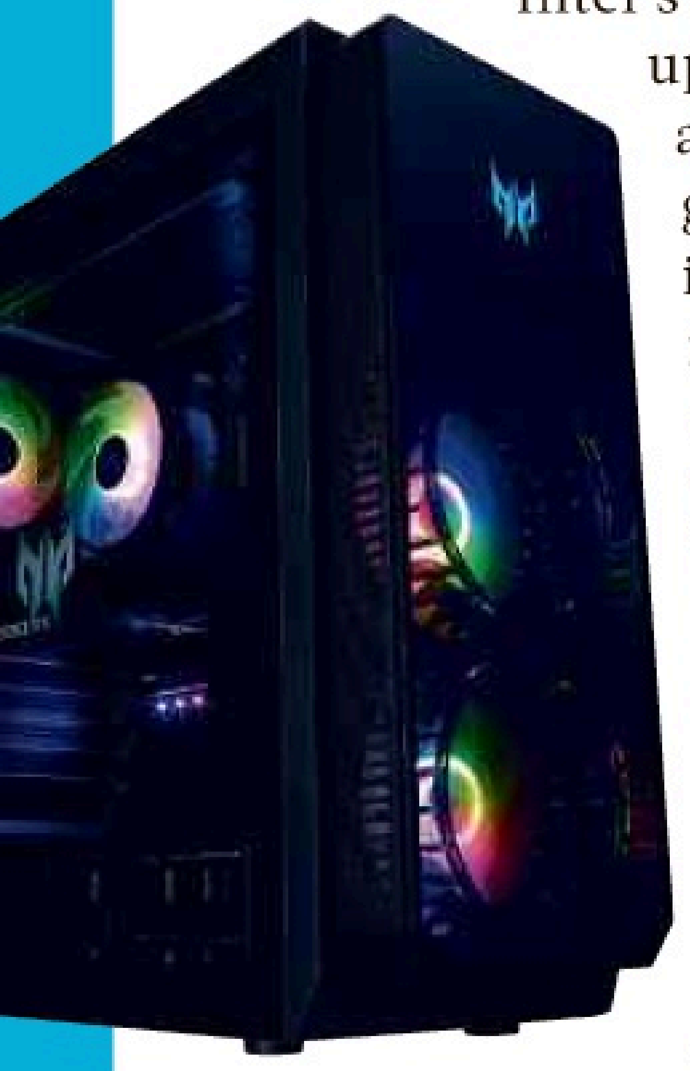
	RYZEN 6000 SERIES										RYZEN 5000 SERIES		
	Ryzen 9 6980HX	Ryzen 9 6980HS	Ryzen 9 6900HX	Ryzen 9 6900HS	Ryzen 7 6800H	Ryzen 7 6800HS	Ryzen 5 6600H	Ryzen 5 6600HS	Ryzen 7 6800U	Ryzen 5 6600U	Ryzen 7 5825U	Ryzen 5 5625U	Ryzen 3 5425U
Architecture	Zen 3+	Zen 3+	Zen 3+	Zen 3+	Zen 3+	Zen 3+	Zen 3+	Zen 3+	Zen 3+	Zen 3+	Zen 3	Zen 3	Zen 3
Cores	8	8	8	8	8	8	6	6	8	6	8	6	4
Threads	16	16	16	16	16	16	12	12	16	12	16	12	8
Boost frequency	5GHz	5GHz	4.9GHz	4.9GHz	4.7GHz	4.7GHz	4.5GHz	4.5GHz	4.7GHz	4.5GHz	4.5GHz	4.3GHz	4.1GHz
Base frequency	3.3GHz	3.3GHz	3.3GHz	3.3GHz	3.2GHz	3.2GHz	3.3GHz	3.3GHz	2.7GHz	2.9GHz	2GHz	2.3GHz	2.7GHz
L2 cache	4MB	4MB	4MB	4MB	4MB	4MB	3MB	3MB	4MB	3MB	4MB	3MB	2MB
L3 cache	16MB	16MB	16MB	16MB	16MB	16MB	16MB	16MB	16MB	16MB	16MB	16MB	8MB
Default TDP	45W+	35W	45W+	35W	45W	35W	45W	35W	15W to 28W	15W to 28W	15W	15W	15W
GRAPHICS													
Architecture	RDNA 2	RDNA 2	RDNA 2	RDNA 2	RDNA 2	RDNA 2	RDNA 2	RDNA 2	RDNA 2	RDNA 2	Vega	Vega	Vega
Cores	12	12	12	12	12	12	6	6	12	6	8	7	6
Max frequency	2.4GHz	2.4GHz	2.4GHz	2.4GHz	2.2GHz	2.2GHz	1.9GHz	1.9GHz	2.2GHz	1.9GHz	2GHz	1.8GHz	1.6GHz

PC PRO BEST OF CES 2022

GAMING

Acer Predator Orion 5000

Acer is pushing the Orion 5000 under the banner of "raw power", and we can see why. Intel's 12th gen Core i7 processors, up to 64GB of DDR5 memory and GeForce RTX 30 series graphics cards are the core ingredients, with the exact mix depending upon your choice of model. As the photo on the left shows, the obligatory RGB options are in place, but we'd draw your attention to the brooding design of the chassis and its tool-less design. It launches in Europe from March, starting at €1,999.



Alienware m17 R5 Ryzen Edition

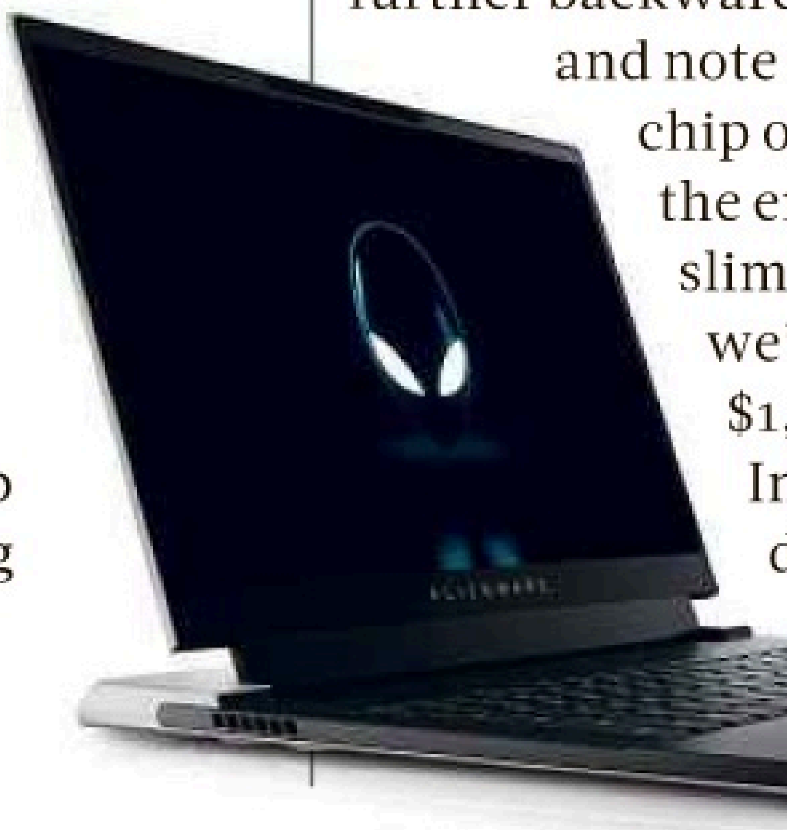
Alienware should surely have gone the whole hog and called this the "AMD Showcase Of All Its Mobile Gaming Technology Edition", for that is what it is. A portfolio of technologies dubbed AMD Advantage are designed to get the most out of every part, whether that's one of the new Ryzen 7 or Ryzen 9 6000 series processors or the Radeon RX 6000 series graphics.

Top of the list is AMD SmartShift Max, which shifts – smartly – the balance of laptop power between the CPU and GPU depending on the game. AMD claims this doubles the performance compared to a Ryzen 5900H CPU, which doesn't support AMD Advantage. SmartAccess Memory gives the Ryzen chip access to the card's GDDR6 memory, while SmartAccess Graphics promises up to 15% higher frame rates by letting the graphics card directly control the display (rather than going through the CPU).

We can't imagine AMD is entirely happy that Alienware still offers GeForce RTX options of the m17 R5 Ryzen Edition, but it's an understandable move for a laptop aimed at heavyweight gamers. Talking of heavy, this 17.3in laptop weighs a hefty 3.1kg. Prices start at $1,599 and it goes on sale this spring.

Alienware x14

In stark contrast to the m17 R5, this 14in gaming laptop is a slip of a thing at 1.8kg and 14.5mm thick. Alienware achieves this by placing the hot-running components at the rear of the chassis and moving the hinge of the screen an inch in from the base. It's a quirky design that means the x14 extends further backwards than a typical 14in laptop, and note the most powerful graphics chip on sale is an RTX 3060, but the end result is indeed the slimmest true gaming laptop we've seen. Prices start at $1,799 for a version with Intel's Arc graphics and it's due to go on sale "shortly".

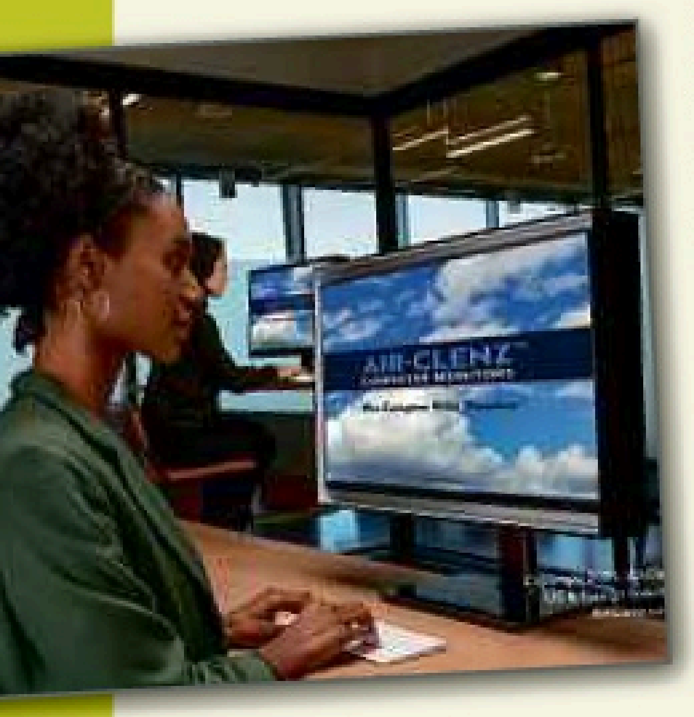


PC PRO BEST OF CES 2022

HEALTH & FITNESS

Air-Clenz

We were cynical about this before we spoke to Air-Clenz at its stand, but we've been won over by the idea. Its inventor's conceit is that when you breathe in an office environment, most particles bounce back from the screen in front of you and then into general circulation. How about using suction to draw them into a filter and remove virus-infected aerosols? And then why not repeat the trick in planes, with a filter effectively built into the back of the seat in front of you? It's clunky, with the prototypes on show at CES adding quite some bulk to regular monitors, but Air-Clenz claims that independent tests prove it works. It told us that it's already talking to monitor makers, and we can well imagine call centres ordering them in droves.



biped.ai

Will this "AI copilot" ever replace a guide dog? Perhaps not, but the idea behind this shoulder harness is intriguing. It uses built-in cameras to construct the world around you, then feeds back the information via 3D spatial audio. It then warns the wearer of oncoming obstructions, noting whether they're fixed (such as a bollard) or rushing towards them, whether that's pedestrians, bikes or cars. It's aiming for a full launch in Europe this autumn, but hasn't confirmed prices.

Garmin Venu 2 Plus

Garmin launched two smartwatches at CES. The first was the fashion-conscious Vivomove Sport, complete with moving hands to make it look like a normal watch. But it's the Venu 2 Plus that piqued our interest, mainly due to its integrated speaker so you can take calls without reaching for your phone (this earns it the Plus over the standard Venu 2). It's also a more complete fitness watch than the Vivomove as it includes GPS. Both phones are available now, with the Vivomove Sport £160 and Venu 2 Plus £400.

HEART RATE
BODY BATTERY
STRESS
Kaitlyn

Huggy

Unusually for this year's CES, Huggy was aimed at people with mental health issues rather than physical ones. Stripped back to basics, it's an air-inflated vest that gives you a hug when you need it. But there's more to Huggy than that, with sensors that feed back biometric data such as heart rate and "electrodermal activity" to indicate stress. That information will be sent back to caregivers and can be used to automatically inflate the vest. Child vests cost $250, adult versions $300, direct from **dolbomdream.com**.

PlayPulse One

If there's one thing that Peleton has taught us, it's that exercise bikes are boring. We need something to stop them becoming clothes horses, and PlayPulse's trick is a simple one: to create a gaming bike. It currently has ten games under development, with the idea being that the faster you pedal, the better you'll do. Perfect for racing games. Or you can watch streaming videos... but stop pedalling and the shows stop too.

At the time of writing you could sign up to an October 2022 delivery for £1,499, and the company assured us that it can ship to the UK. And note that the PlayPulse Live subscription, which you'll need for full access to custom games and modes, costs $20 per month after the first six months.

Asus ROG Flow Z13

Asus isn't afraid to defy convention when it comes to design, as we see with the ZenBook Fold, and this gaming tablet once again leads where others will surely follow. Think supercharged Surface Pro and you won't go too wrong, with a detachable keyboard and a kickstand built into the rear. Here, though, Asus ramps up the power with a 12th gen H series Intel Core processor and Iris Xe (Core i5 version), GeForce RTX 3050 (Core i7) or GeForce RTX 3050 Ti (Core i9) graphics. The top-end version includes a 3,840 x 2,400 screen tuned to the DCI-P3 space, while the other two are more modest 1,920 x 1,200, sRGB affairs.

We don't yet know prices, but we do know we desperately want to test the Z13 when it lands, hopefully this side of summer.

Samsung Gaming Hub

Our final inclusion from Samsung's packed CES is the Gaming Hub, which bypasses consoles, PCs and laptops altogether. Instead, Samsung wants to offer its smart TV buyers the chance to use cloud gaming services such as Nvidia's GeForce Now and Google's Stadia. Anything to make these services easier to find and use has to be a good idea.

FARCRY6
ASSASSIN'S CREED VALHALLA
IMMORTALS FENYX RISING
STADIA
utomik

HP Omen 45L

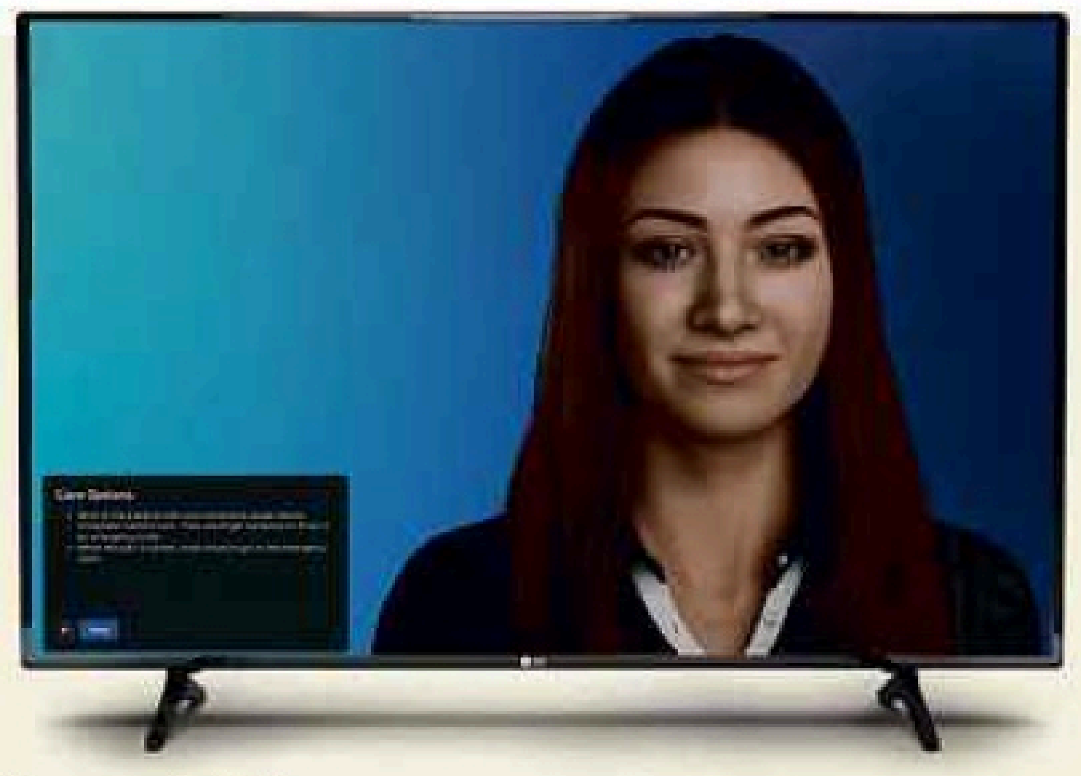
We've been fans of HP's Omen desktops since the 25L variant won our desktop PCs Labs (*see issue 323, p88*). The 25L has only had a mild update in 2022 – a white ceramic colour option and an upgrade to the latest AMD and Intel chips – but the 45L benefits from an all-new "Cryo Chamber". Not for preserving the brains of rich people, but to house a liquid cooler and draw in air from outside rather than use the already warm air inside the chassis. HP claims the CPU will operate 6°C lower as a result. As we went to press, one model – with a Core i9-12900K, 32GB of DDR4 memory, a 2TB SSD and GeForce RTX 3080 Ti – was already on sale, at a juicy £3,300.

Razer Project Sophia

It's go big or go home in Las Vegas, and Razer certainly plumped for the former. The Project Sophia prototype is a modular gaming desk with a huge 65in or 77in display for full immersion, plus a host of magnetic, swappable modules that can be snapped in under the glass surface of the desk itself.

Those modules might include a RAID controller, programmable hotkeys, spatial surround-sound controls or a system-monitoring module, most of which seem to have their own touchscreen displays.

Razer has form for outrageous concept devices unveiled at CES that never see the light of day, so don't expect this one to be



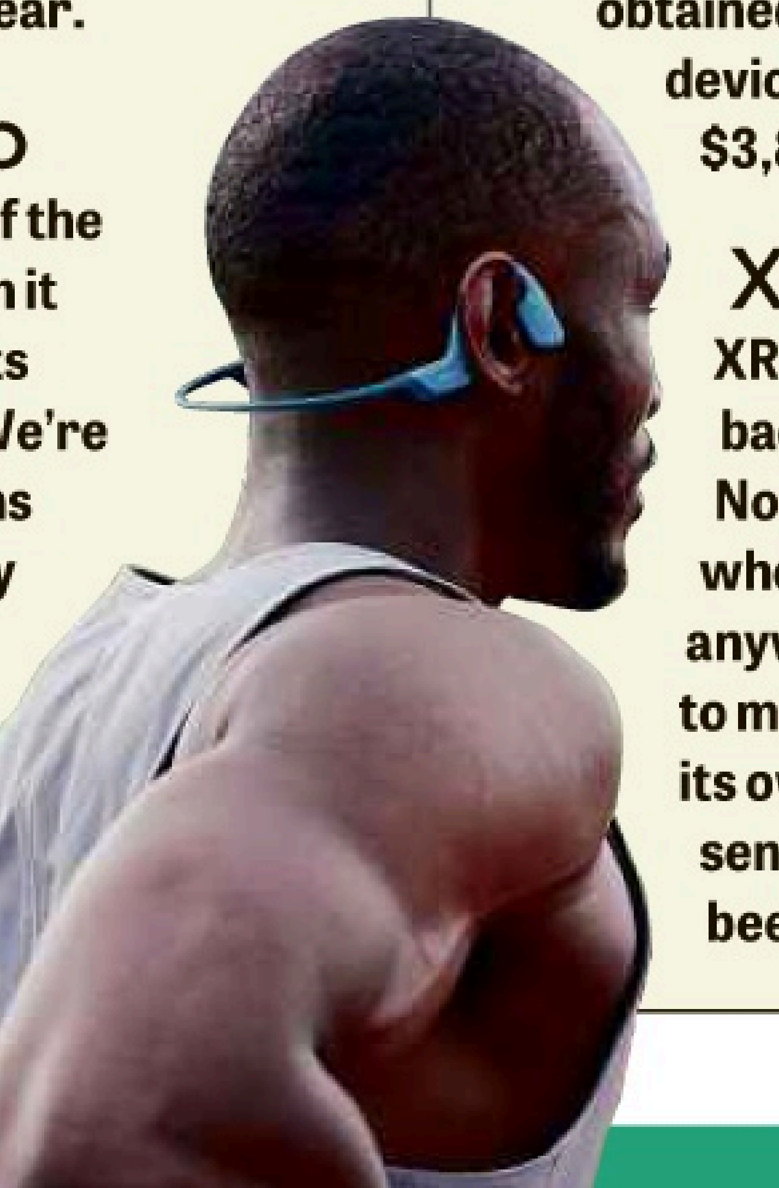
MayaMD

Maya is designed to be an AI health assistant that can triage hundreds of conditions in under 90 seconds. It's been around for some time, and now boasts 94% triage accuracy – and, through a pilot scheme with LG, will soon appear on smart TVs.

Not only can you tell Maya your symptoms and get a recommendation, but she can also check in with you to see you're following treatment. She can even guide you through the steps of recovering from an operation. Sadly there are no plans to bring this to the UK in the immediate future, but MayaMD already has a presence in the US and will launch in the EU this year.

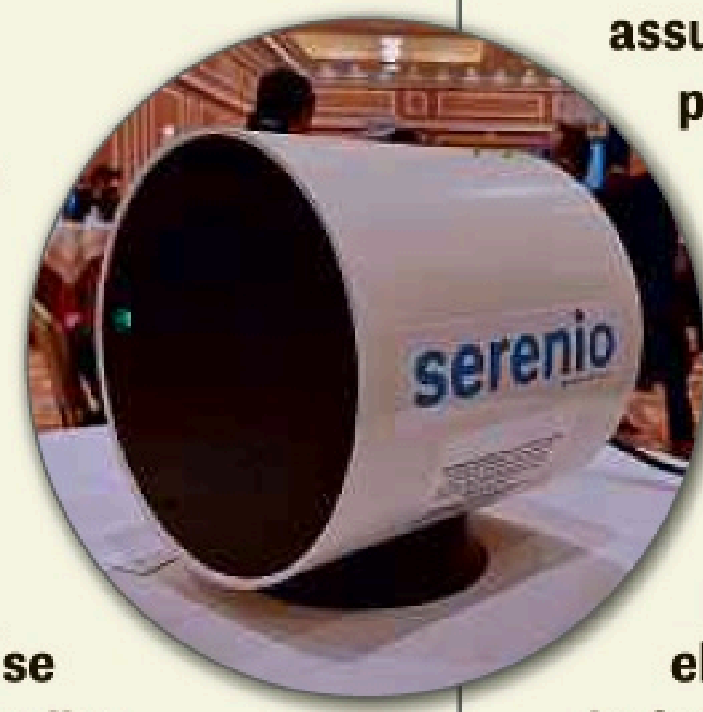
Shokz OpenRun Pro

It was great to see Shokz at one of the CES events, and even better when it handed over a review sample of its new OpenRun Pro headphones. We're regular users of previous versions of Shokz's products (the company was previously called Aftershokz), but the OpenRun Pro set is a significant step up in terms of music playback – not Sony XM4 levels of quality, but good enough to make you forget it's using your bones to transmit the sound. Other plus points include quick charging (90 minutes from a five-minute charge), ten-hour battery life and super light weight. We've worn them for hours at a time. The big downside: these headphones aren't cheap at £180.



Serenio

Another Covid-busting idea on show at CES were these curious air filters by Serenio (serenio.com). Roughly the size of a demuhidifier, they create "an invisible cloud of electrons" that binds with the infamous spike proteins (which have a positive charge) to then neutralise them. It's a clever idea and, according to a bio safety lab in The Netherlands, it's effective: Serenio quotes a "94.9% reduction in infectious SARS-CoV-2 virus particles was obtained after 15 minutes exposure to the device". You can buy units now, but with a $3,800 price they don't come cheap.

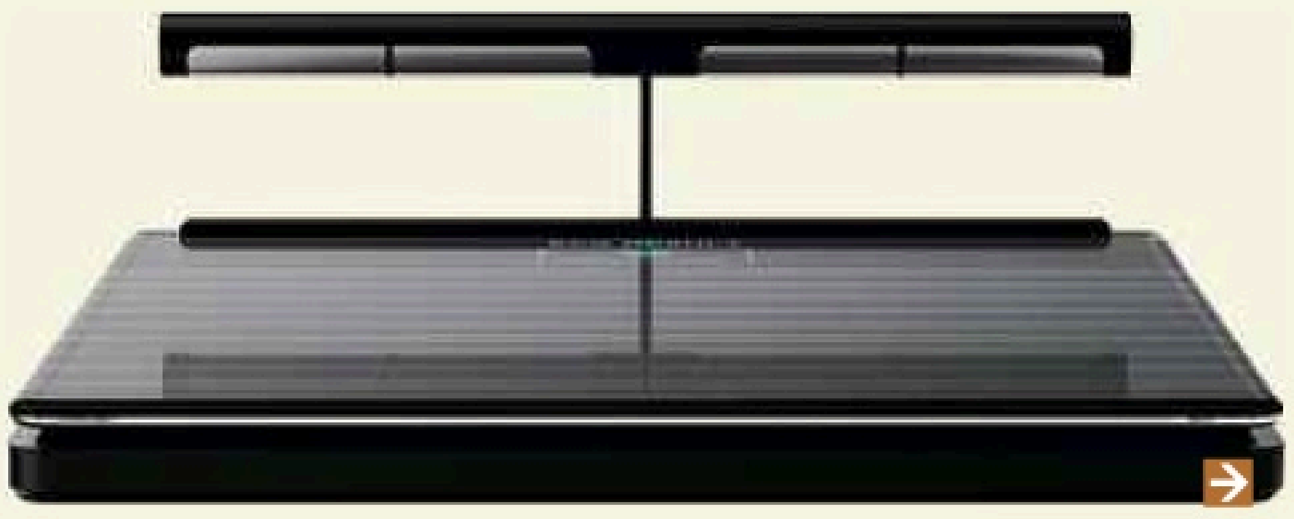


XRHealth

XRHealth is one of the companies being backed by an LG initiative called the LG Nova Global Challenge (lgnova.com), where it's helping startups – based anywhere in the world – take a product to market through direct investment and its own resources. Here, the idea is to send patients VR/AR headsets that have been preloaded with a selection of telehealth services to provide virtual treatments, such as guiding them through a set of shoulder rehabilitation exercises. They can also interact directly with therapists via the headset. It sounds a bit, well, meta, but the company assured us that it works – particularly for people in assisted living environments. The product is already live in the US.

Withings Body Scan

Take two electrodes into the bathroom? Not any more. Via 14 on the footplate and four more built into its pull-up handle, the Body Scan sends electricity through your body like never before in its quest to detect every aspect of your health and body composition. A six-lead ECG can "detect atrial fibrillation, the most common arrhythmia, in only 30 seconds". And it goes beyond typical body-fat measurements to detect exactly where that fat is sitting, along with muscle mass. It can even measure nerve activity in your feet. Subject to the usual FDA checks for the sensors, the Body Scan will launch in the second half of 2022 for $300 (there's no UK price yet).



WEIRD & WONDERFUL

Boogie Board VersaNotes

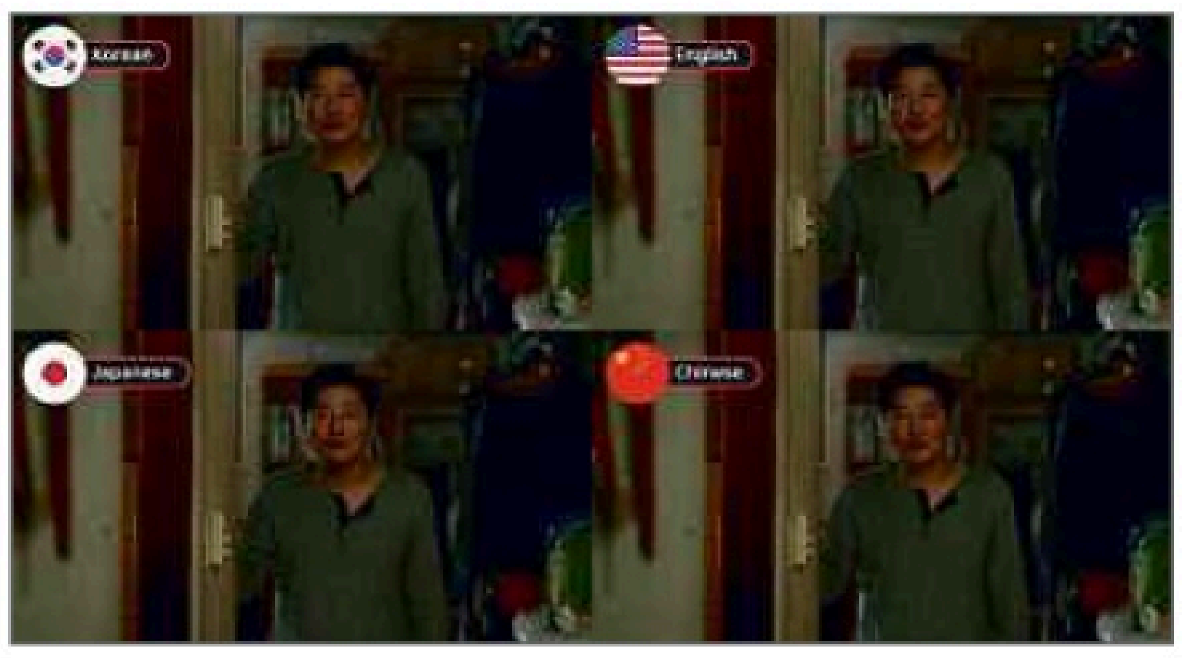
The great thing about talking to Boogie Board about its VersaNotes was its avoidance of phrases like "electronic Post-it notes". For that's what these are, but the company can't say that publicly. Instead, they told us, it's "a quick sort of sticky note, which you can write on and then stick on a magnetic surface". You can write using anything – your finger, a stylus – but to erase it you need to use the supplied "pencil" by tapping on the corner of the note with the pencil's top. There's no clever syncing with apps here: it's a straightforward note. It's admirably simple and, as we saw on the stand, it works. They're due out in the spring with a starter pack that contains three notes in two sizes: 4 x 4in for $25, 4 x 6in for $30.

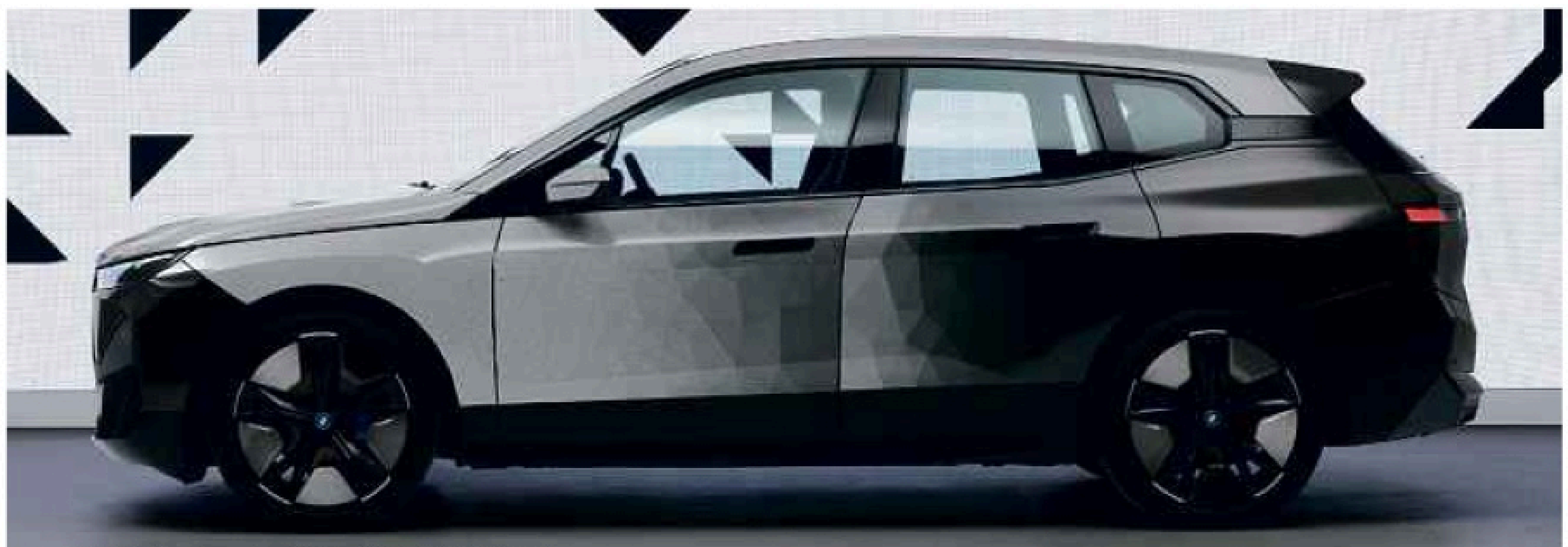
BryghtLabs ChessUp

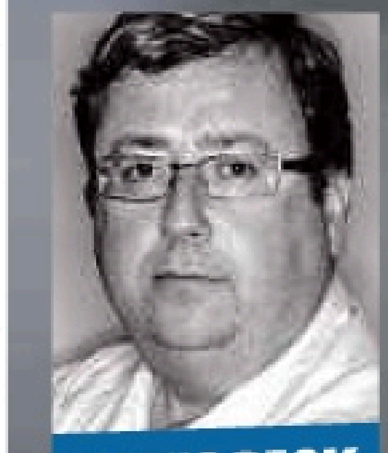
We interviewed BryghtLabs' director of chess, grandmaster Tatev Abrahamyan, as part of our AI in chess feature on p38, after seeing her play on its ChessUp board at CES. The idea behind this board's name is that it ups your skill level to match your opposition: touch a piece and the available moves appear, rated from strong red to strong green depending on the quality of the move. There's also a chess lesson library for you to bone up on your skills, plus integration with Chess.com and Lichess so you can play anyone around the globe whenever you want. Pre-order at **bryghtlabs.com** for $329, with delivery worldwide from April.

Klling

This demo stopped us in our tracks on the showfloor. A tablet's screen split in four, showing the scene of a TV show in four languages with the actors' mouths moving to match. If this technology works as well as South Korean parent company klleon (**klleon.io**) claims, then painful dubbing is a thing of the past. It currently works in Korean, Japanese, Chinese and English, and aims to convey actors' emotions when it adjusts their voice. And it doesn't take much time: three days to "dub" a two-hour film. Or, to put it another way, a mere fortnight to adapt series one of *Squid Game*.







JON'S PICK OF CES

BMW iX Flow

CES is always notable for its wholly inappropriate misuse of technology. This year the prize goes to BMW, which wrapped one of its iX SUV vehicles in a skin of E Ink. But rather than slapped into a Kindle, here it has been wrapped around the car in the same way that you put paint protection film (PPF) onto a Ferrari.

That, in itself, would be interesting – but BMW went further. The sheets of E Ink wrap are addressable, so the "paint" colour can shift from black to white. And do so at a small addressable dot size too. Some commentators noted that it allowed for different panels to have different shades of grey. Maybe 50, even.

Surely it won't be long before it's possible to have this in colour, too: imagine, a chameleon colour-shifting BMW under the control of the driver! Maybe it could be deep red to express the pent-up anger of the typical BMW driver. Or engage a calming turquoise if the car detects a cigar or pipe being smoked.

Actually, given that it can show patterns in the panels, it's probably appropriate for the driver to choose wording and signage to appear. I think "Get out of my way" should be instantly available from a steering wheel button.

Oledcomm LiFiMAX Tab

Remember Li-Fi? It's faded into the background compared to Wi-Fi, but the idea is simple: send data via modulated LEDs, switching them on and off 30 million times per second in its latest iteration. This avoids radio waves and is more secure; if you can't see the light, you can't intercept it. And latency is a low 4.5ms. "It's perfect, for instance, in dense connectivity environments," Benjamin Azoulay, Oledcomm's CEO, told us on the showfloor. "If you have a classroom with 30 children connecting at the same time it is a fantastic technology even compared to Wi-Fi 6."

In July 2021, the company announced its first integrated circuit (IC) with Li-Fi built in. At CES, it launched the LiFiMax Tab, a 10in Android tablet that includes the IC so that customers no longer need to plug in a Li-Fi adapter to make the technology work. These tablets connect to a Li-Fi access point, much like Wi-Fi. It plans to roll out 10,000 tablets to schools in France (and one in England) this year, but its long-term aims are to offer its IC to other smartphone and tablet makers. "I don't believe that Li-Fi will replace Wi-Fi, to be very clear," said Azoulay. "I believe there is a niche market, which is a big niche, which are the older applications where radio waves are forbidden and we provide wireless in those solutions."

Azoulay says the LiFiMax Tab is "instantly available" to existing customers, at a cost of €400 per unit, but due to shortage of components and high demand it will take "three to four months to deliver to [new] customers".

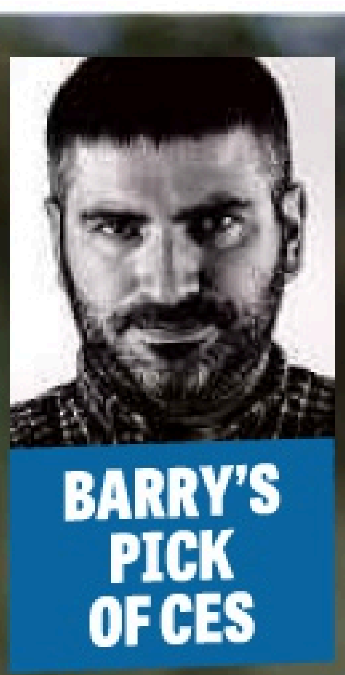
NexPad

Nex Computer has already gained fans with its £369 NexDock, a lightweight 13.3in laptop that uses your phone as its brain. Simply plug it in via USB-C. At CES, it was demoing the self-explanatory 27in NexMonitor (2K for $449, 4K for $549) and also the NexPad (*pictured below*). This is a 12in portable monitor complete with kickstand, so if you supply a keyboard and mouse then it will work with any phone that has a desktop UI on tap – Nex's spokesperson mentioned Huawei and Samsung by name. A magnetic bottom means you can still use the phone to act as a mini second screen. And just to add extra flexibility, you can use the NexPad as a second monitor for a MacBook or Windows laptop with a USB-C display output. Clever.

TCL Nxtwear Air

The Air is TCL's second iteration of wearable display glasses, with the big idea that you can enjoy the equivalent viewing experience of a 140in screen from 4m away via a pair of 1080p micro OLED displays. "Watch, game and work anywhere," proclaimed TCL, "as Nxtwear Air untethers users from offices, living rooms and small airplane screens."

OLED will mean punchy colours, and there's also the promise of stereo audio via a pair of speakers built into the frames. The big question is how comfortable they are to wear. TCL's first such glasses, the Nxtwear G, were bulky and uncomfortable, but the 75g Air set looks much closer to a normal pair of glasses. There's no release date or price as yet.


BARRY'S PICK OF CES

Bird Buddy

In a world where everything from toothbrushes to thermostats have gone smart, it was only a matter of time before they came for the bird tables. Bird Buddy has a packed nest of clever features, too.

The associated app alerts you when a bird lands on your feeder, letting you remotely snap photos from the feeder's built-in camera. You can rewind after you get the alert, much like a Ring doorbell, in case you don't react in time to snap your feathered visitor. Bird Buddy's software also identifies the bird automatically and adds it all to your collection of spotted species.

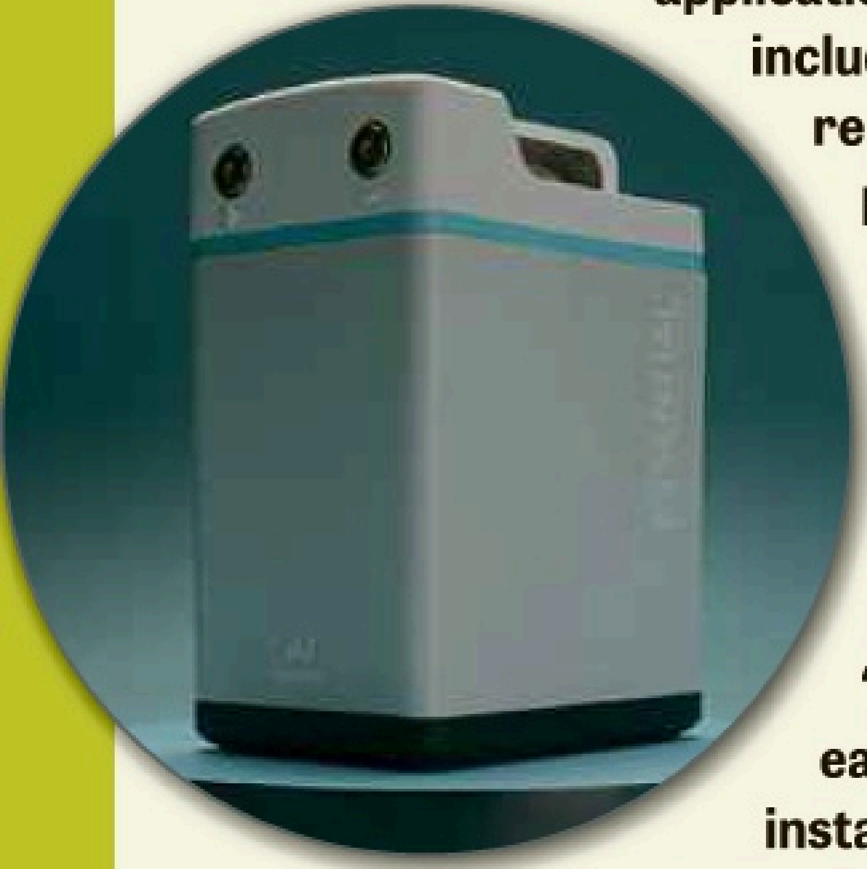
With an affordable $199 price and no ongoing subscription fees, Bird Buddy is a simple way to reconnect with the nature in your back garden. It's easy to see why it has smashed through crowdfunding targets.

Alas, the success of those Kickstarter campaigns mean orders are now backed up, so even if you pre-order now you won't see your Bird Buddy until May at the earliest. Still, one swallow doesn't make a summer...

BEST OF BRITISH

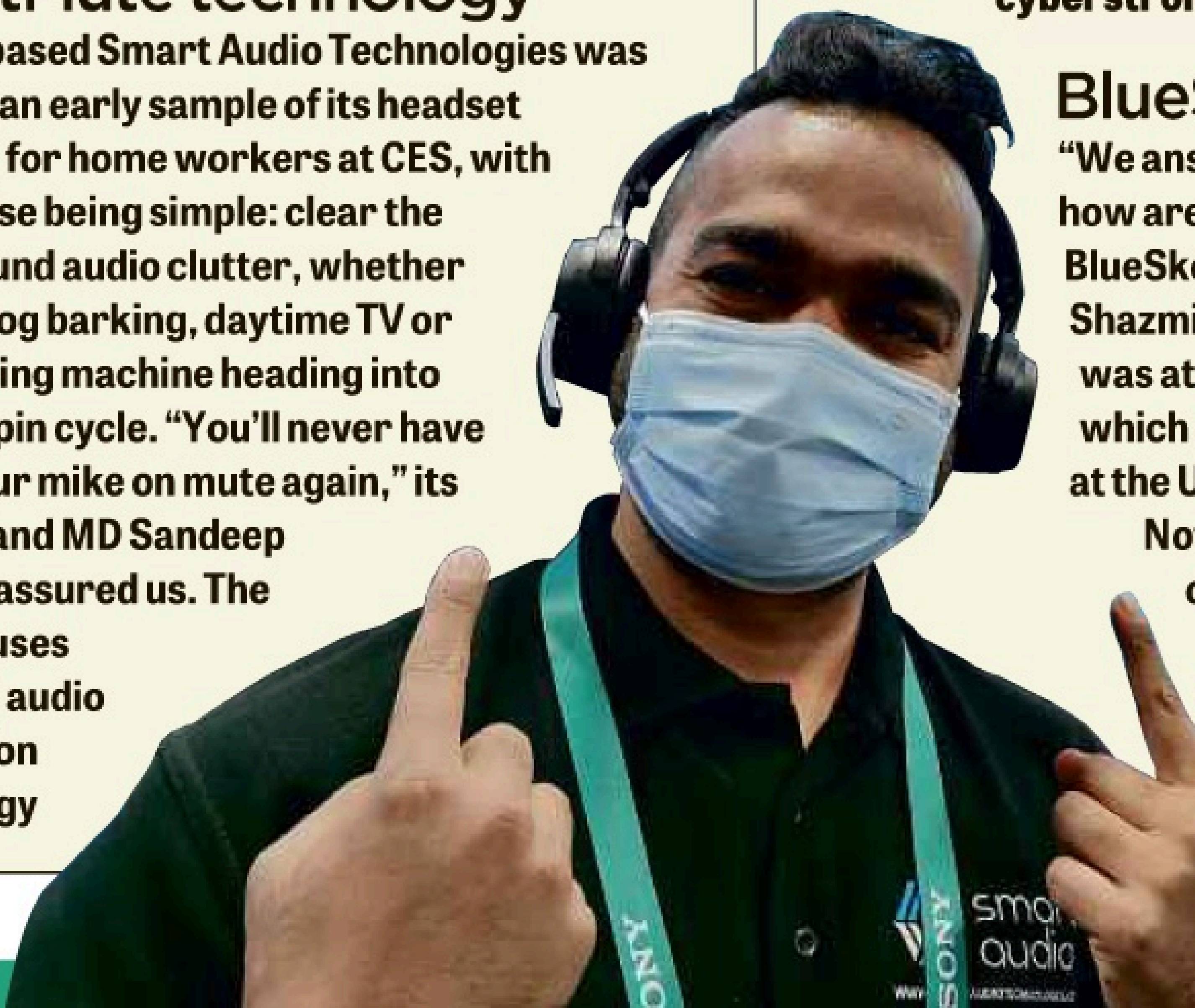
Aceleron Essential Battery

Aceleron was one of a handful of British startups at CES this year, and we think it's onto a winner. Its big idea is modular, easy-to-reuse and easy-to recycle lithium-ion battery packs for use in anything that requires what co-founder Carlton Cummins describes as "stationary energy storage applications". So that could include everything from renewable energy power stations to specialist vehicles, with Carlton listing coffee trucks, canal boats and ambulances as successful areas. "The technician can easily rock up and install six of these [*the battery pictured, left*] and the capacity of the new ones is 15% more in three years' time. He takes the old ones back to do any maintenance and repair he needs to redeploy to a new customer." Sold.



SmartMute technology

London-based Smart Audio Technologies was demoing an early sample of its headset designed for home workers at CES, with its promise being simple: clear the background audio clutter, whether that's a dog barking, daytime TV or the washing machine heading into its final spin cycle. "You'll never have to put your mike on mute again," its founder and MD Sandeep Chintala assured us. The headset uses AI-based audio elimination technology it dubs SmartMute to achieve this, and after trying it ourselves on the showfloor we can agree that it slashes background noise, albeit while clearly compressing our own recorded voice. The business-focused headsets will ship this year and cost around £300, with SmartMute-toting gaming headsets and hearing aids to follow.

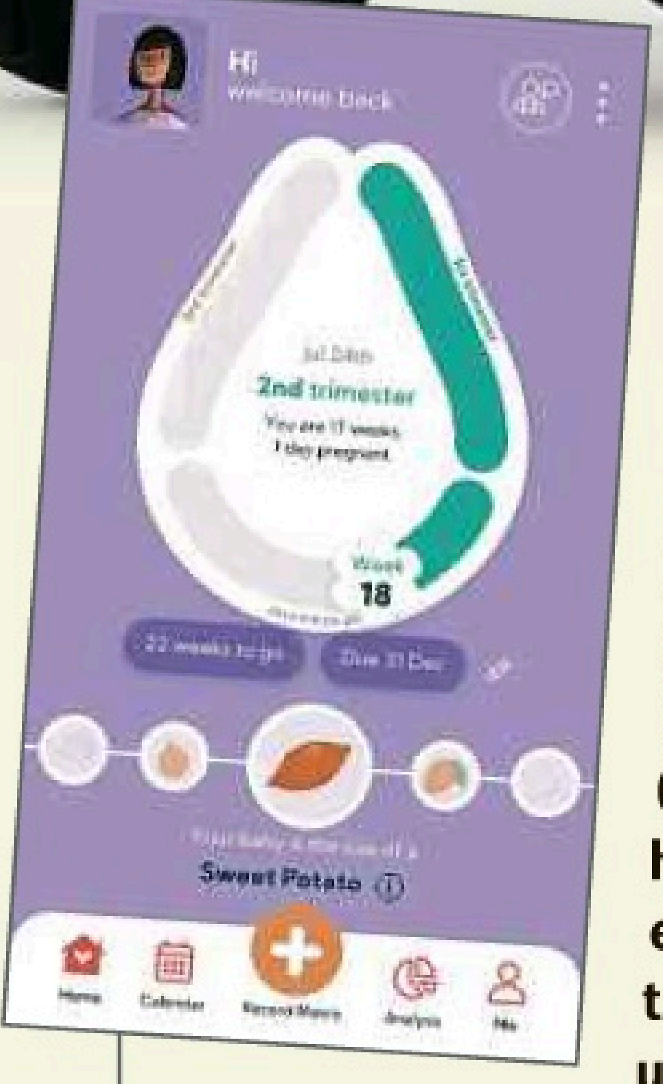


CyberStroller

We're pretty sure this is the first time we've included a pushchair in *PC Pro*, but the CyberStroller is that little bit different. For example, an LCD control dial built into the handle lets you control the pressure of the front wheel – including settings for jogging and bumpy terrain. Then there's the optional camera (£90), which allows you to monitor your child via the accompanying app. But perhaps the most advanced feature is its ability to monitor and filter the gases your child is breathing, such as particulates and nitrogen oxide from car exhausts. The model on show at CES looked ready to roll, and you can pre-order now at cyberstroller.co.uk from £1,299.

BlueSkeye AI

"We answer the question of how are you feeling." That, BlueSkeye's UX specialist Shazmin Majid explained, was at the heart of this AI, which grew from an idea at the University of Nottingham into its own startup. BlueSkeye combines facial analysis with human behaviour data to work out people's moods, and was using CES to launch its SDK for partners. In partnership with a scan provider, it has already created an app called Avocado by BlueSkeye that aims to support women through the challenges of pregnancy (and beyond). "That looks at how people are feeling by engaging them in a variety of tasks," said Majid. "We've used that with pregnant women to feed back their mood [which can] help with post-natal depression, pre-natal depression, that kind of thing." But the AI isn't just for apps: "It's kind of unlimited what we can do." ●



CAN AI SOLVE CHESS'S STALEMATE?

AI has been blamed for dragging professional chess into an endless succession of draws. But as **Barry Collins** discovers, it's also injected new life into the game – for both pros and amateurs

AlphaGo
Lee Sedol

TOP **Garry Kasparov in his first meeting with Deep Blue in 1996**

ABOVE **AI has also been used to great effect in another strategy game, Go**

AI will ruin chess. It will turn players into robots, encourage the "endless dry manoeuvring" that normally leads to drawn games, as former world champion Garry Kasparov warned in a 2018 article for *Science* magazine.

That was the conventional wisdom, and it certainly looked like it was coming true. Take that year's World Chess Championship between Magnus Carlsen and Fabiano Caruana, where all 12 games ended in a draw. The match had to be decided on the chess equivalent of a penalty shoot-out – three games of rapid chess – to find a winner.

"You're starting to have a real problem when you have 12 classical games drawn," said Nigel Short, the former World Chess Championship finalist, speaking exclusively to *PC Pro*.

It looked like being a similar scenario in the latest World Championship, held in December 2021, when Carlsen and challenger Ian Nepomniachtchi recorded five consecutive draws in the opening salvo of games. The deadlock was only broken after an eight-hour, 136-move battle of attrition in game six – the longest game ever in the World Chess Championship's long history.

Have players trained laboriously by AI engines made the pro game more boring? Perhaps, but there's also evidence of the opposite: that new forms of AI, which taught themselves how to play the game, are becoming more creative. More, dare we say it, humanlike. That 2018 Kasparov article we talked of earlier? He wasn't bemoaning AI, but praising DeepMind's AlphaZero for adopting a "dynamic, open style like my own".

Whatever the impact of AI on the pro game, the deadlock among the world's elite players isn't putting players off the sport. Far from it. A combination of lockdowns, Netflix series *The Queen's Gambit* and the emergence of a generation of Twitch-streaming grandmasters has made chess more popular than ever before. Not to mention the AI, which is teaching millions of new players how to play the game.

"We've got almost five million daily players on **Chess.com**," said the site's founder, Erik Allebest. "That's four or five times bigger than it was before Covid and *The Queen's Gambit*, and those players are now sticking around. It wasn't just a bump and they're gone, they're staying."

However, they're not hanging around for eight-hour marathons. In much the same way cricket has shifted from five-day tests to 100-ball slogfests, so chess has adapted for the shorter attention spans of the streaming generation. Just as the world's biggest cricket stars have shifted to formats such as The Hundred, so you'll find Carlsen and other top pros playing in the World Blitz Chess Championships and even faster formats such as Bullet, where the total time afforded to each player in a game can be as little as one minute.

Chess has been transformed by technology, in good ways and bad.

From Deep Blue to DeepMind

As Kasparov himself lamented in that 2018 essay for *Science* magazine, computers' superiority over humans when it comes to chess is nothing new. Indeed, he was infamously the first high-profile victim a quarter of a century ago.

In 1996, Kasparov took on Deep Blue, IBM's cabinet-sized supercomputer. The then world chess champion triumphed 4-2 in their first match in Philadelphia. But when they faced each other for a rematch in New York the following year, it was Deep Blue that took the crown, forcing Kasparov to resign in fewer than 20 moves in the decisive sixth game to claim a $3\frac{1}{2}$-$2\frac{1}{2}$ victory. It was the first time a world champion had been beaten by a computer in a match using standard time controls,

New forms of AI, which taught themselves how to play the game, are becoming more creative and left Kasparov somewhat bitterly complaining about human intervention in the games and being denied access to previous games the supercomputer had played.

Deep Blue wasn't a creative chess player, more a weapon of brute force. It was fed a huge library of openings and endgames, and IBM hired chess grandmasters to help fine-tune the computer's chess skills. It could evaluate 200 million chess positions per second, using raw processing power to evaluate the optimal moves. It was basically doing what its expert programmers told it to.

The AI used to develop today's chess-playing AI is a different beast altogether, and it's best exemplified by the work of Google-owned DeepMind.

The British company originally applied its AI to mastering another game, Go. The first version of DeepMind's AlphaGo software was taught how to play Go by studying a library of previous matches and by playing thousands of matches with amateur and professional players – not dissimilar to the way IBM taught Deep Blue to play chess. However, unlike Deep Blue, AlphaGo honed its skills by playing thousands of matches against itself. It became its own teacher, exploring different moves and strategies to find out which worked best. It didn't care how it won, it didn't try to emulate other Go players; it devised game-winning strategies all by itself, with minor corrections from the team when it did something obviously wrong.

BELOW Nigel Short takes on Kasparov in the World Chess Championship

AlphaGo Zero didn't benefit from any libraries of previous games – it was completely self-taught

In a similar vein to Kasparov's showdown with Deep Blue, AlphaGo pitted its skills against the world's best Go player, Lee Sedol, in 2016. There is a superb 90-minute documentary about the match that's free to view on YouTube (**pcpro.link/330alphago**), but there's no way to finish this article without dropping a massive spoiler: AlphaGo wins. And wins handsomely.

The documentary is still worth watching just to see the reaction of Lee Sedol. He enters the tournament sure that the AI won't beat him, despite having seen it crush the European champion. His confidence is ripped away almost immediately, as Sedol stares in disbelief at some of the moves AlphaGo plays. Move 37 in the second match leaves the world's best player visibly stunned.

He wasn't the only one. The commentators broadcasting the game live to an audience of millions in Korea are equally gobsmacked, but AlphaGo is thinking 50 or 60 moves ahead; a move that makes no sense on the board as it stands currently is going to prove pivotal in an hour or so's time. "This is kind of unthinkable as a human Go player," said one of the South Korean commentators, "but what if she [AlphaGo] knows everything about what's going to happen next?"

AlphaGo doesn't know everything, but it only made one blunder in the five-game series on its way to a crushing 4-1 victory. Lee Sedol's range of reactions in the post-match press conferences swing from outright despair to humble respect for the AI team, not least in his reaction to that pivotal move 37 in the second game. "It's not a human move," Sedol said after the game. "I've never seen a human play this move. So beautiful."

Zero-sum game

AlphaGo was succeeded by AlphaGo Zero, so called because it didn't benefit from any libraries of previous games or matches against human beings – it was completely self-taught. It was fed the rules and left to get on with it. It surpassed the strength of the AlphaGo software that beat Lee Sedol within three days, battering it 100-0 in a match.

Having mastered Go, AlphaGo Zero was converted into a more generalised algorithm called AlphaZero in 2017, and this time it taught itself how to play chess. Instead of taking on human opponents (no-one is daft enough to even try any more), AlphaZero set about dismantling the best of the chess engines, namely Stockfish 8. Just as AlphaGo's infamous Move 37 had shocked Lee Sedol with its sheer audacity, AlphaZero had the chess experts reeling after it launched an outrageous attack in one of the many games it played against Stockfish, sending a bishop deep into enemy territory where it was easily picked off by one of Stockfish's pawns.

No professional player at the time would have made that move, the chess commentators concluded, but AlphaZero's bold move opened up a tight board, almost immediately putting Stockfish on the back foot and eventually forcing victory. AlphaZero won the series comfortably.

DeepMind's staff research engineer, Nenad Tomasev, told us that AlphaZero gave pro players the confidence to take on moves that were previously regarded as too risky. "When AlphaZero appeared, it came to the stage with a number of fresh ideas in certain types of opening and middlegame positions," he said.

"Perhaps the most striking was AlphaZero's fondness for early flank expansion via a4 or h4 – an idea that was certainly known, but wasn't held in high regard and was thought of as weakening and premature in the specific positions where AlphaZero had utilised these moves to a great extent. I haven't looked at move statistics more formally, but anecdotally a number of top grandmasters have been trying similar ideas following this discovery," Tomasev said.

That swashbuckling style differed from the other engines that the pros were training with. "AlphaZero's uncompromising attacking play and the willingness to give up material in order to gain the initiative and restrict the opponent's pieces was equally prominent," said Tomasev. "In addition, its positional sense helped players reassess positions that were being evaluated as equal by traditional engines at the time, and find new and creative ways of pushing for a small edge." (*See 'What's next for AlphaZero' on p41.*)

AlphaZero's style even won praise from a man who's got more reason to be sceptical of AI than most. "AlphaZero prioritises piece activity over material, preferring positions that to my eye looked risky and aggressive," Garry Kasparov wrote in that 2018 piece for *Science*. "Programs usually reflect priorities and prejudices of programmers, but because AlphaZero programs itself, I would say that its style reflects the truth. This superior understanding allowed it to outclass the world's top traditional program despite calculating far fewer positions per second. It's the embodiment of the cliché, 'work smarter, not harder'."

Teaching pros to be more human

Could AlphaZero's more aggressive, creative style encourage the professional players to follow suit and ease the deadlock seen at the World Championships? Nigel Short, the first and only British player to have a shot at the World Chess Championship when he faced Kasparov in 1993, believes so.

Short agrees that constant training with AI opponents has made the top professionals more computer-like, but says AI "has also expanded the game, because players are aware of many more possibilities, which they weren't in the past".

With players training relentlessly with their preferred AI engines, Short argues chess has entered something of an "arms race", and that the very best players are – like AlphaZero – having to find creative ways to outsmart rival engines. He cites the performance of Magnus Carlsen in the recent World Championship, who "very, very cleverly goes for positions which are not necessarily the first choice of engines when we're looking at the opening phase".

"He's aiming for certain types of positions, and his view – which is quite reasonable – is that he's a better player than anybody else," said Short. "So, if he negates the use of engines to some degree, then he will come out on top. If something is a fourth-best choice [for chess engines] and it looks interesting to him, he may pose some problems [to his opponent]."

Chess has been pushing internet technology from the beginning, as it's such a natural two-person game

Amateur boomtime

If computers and AI have had a massive influence on the pro game, they've had an even more dramatic effect on how amateurs play.

"Over the last twenty-plus years, it's transformed the game entirely," said Chess.com founder Erik Allebest. "[Before internet chess] people had to find coffee shops and clubs, but now you can play chess anywhere – you play chess on your computer, on your mobile phone. And that started with early chess servers. Chess has been pushing internet technology from the beginning, because it's such a natural two-person game. So it's introduced chess to more people, but also the number of chess games played per day on the planet has skyrocketed because it's so easy to do."

And although Allebest highlights the internet's ability to pair opponents across the planet, the ability to play an intelligent AI opponent shouldn't be underestimated either. Even in the midst of a pandemic where we were often robbed of human contact, players often still preferred to take on AI rather than a flesh-and-blood opponent. "We didn't recognise the importance of playing the AI until maybe a couple of years ago when we really started to track that," said Allebest.

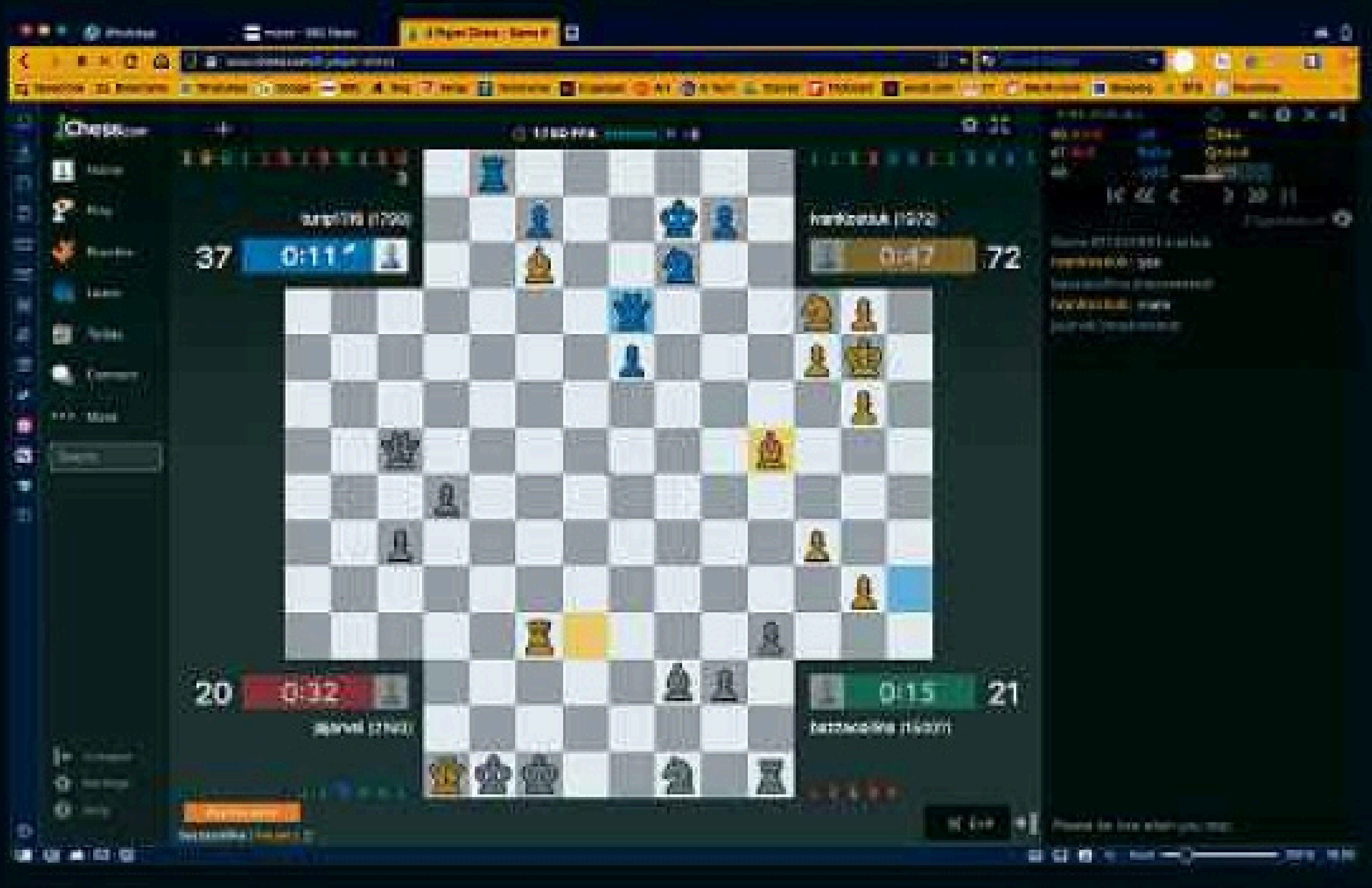
"We noticed that while we have slightly more people playing against humans, the number of people playing the AI was so much higher than we even knew before we started looking at it because people like the lower pressure, you can quit any time without feeling bad. You don't feel so dumb because you're losing to a computer. It just lowers the

ALTERNATIVE CHESS APPS

Bored of playing chess the conventional way? Here are three apps that offer variations on the classical game.

Four-player chess at Chess.com

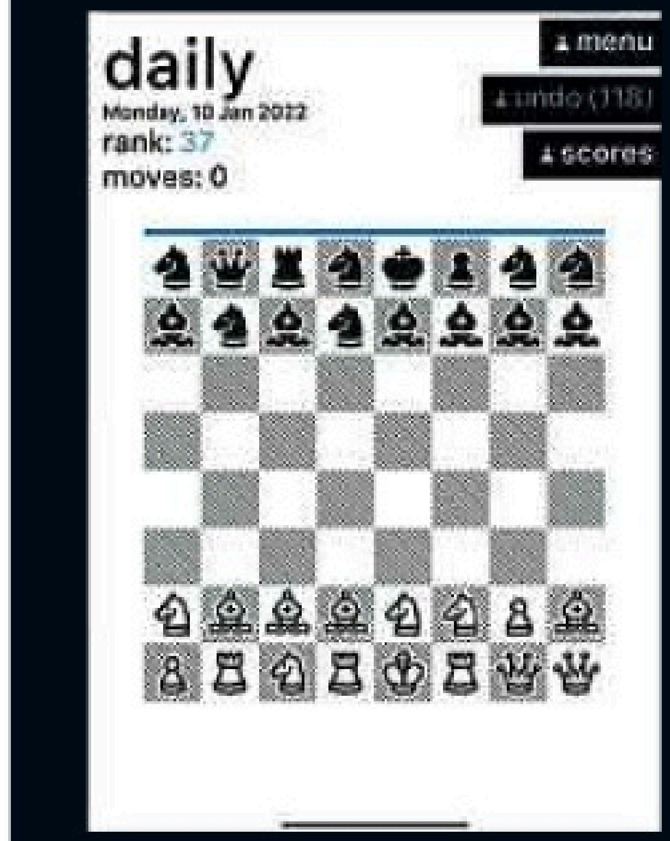
Variant only available via the browser



If trying to figure out where your opponent is going to move next is too simple for you, try working out where three other players on the same board might go. Four-way chess is enormously challenging, not least because it's also played against the clock, heaping even more pressure onto your decisions. Rules are as normal, with pawns getting promoted on the eighth rank, even though it's not the edge of the board but slap bang in the middle of it. It's the most addictive chess variant we've come across, but you'll need a good lie down after a couple of matches.

Really Bad Chess

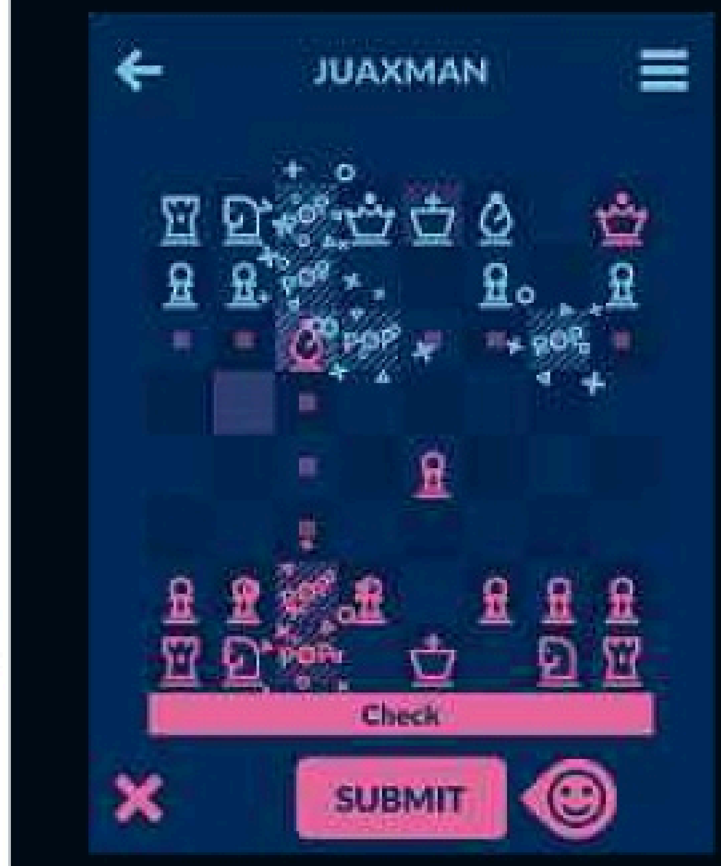
iOS and Android



This developer's marketing might need a little work, but the game is superb. You get a different board each game with pieces placed entirely at random. You might have six queens, three rooks and only one bishop, for instance. Pawns might start on the back rank. Pieces might be completely undefendable from the start. Much like the four-player chess above, it's a head-scrambler and requires huge concentration to not surrender pieces stupidly because your brain is still in conventional chess mode. The app has daily and weekly challenges, as well as a freeplay mode, and the in-app purchases are as unaggressive as they come.

Chessplode

iOS and Android



Chessplode is similar to Really Bad Chess in that the board can be set up with a random configuration of pieces. But just to make your cranium ache a little harder, if you capture a piece, all other pieces in that line and column will explode and be removed from the board – even if they're your own pieces. The only exception to this is if you capture a piece on the king's line and column – then it behaves like a normal chess capture. The app also lets you create your own board and upload it for others to play. The only stipulation is that you've got to beat the CPU player on your own board before you're allowed to upload it!

barrier to enjoying the game, it depressurises it a bit."

Sites and apps such as Chess.com have also lowered the entry barriers for chess players, helping them to learn the game with interactive tutorials and move-by-move analysis of their online matches. After every game on Chess.com, for example, you get a breakdown of how many great moves and blunders you've made, with the opportunity to replay the match from the pre-gaffe position and learn from your mistakes. "The coach feature is there to explain why your move might have been bad, why it might have been good, to celebrate with you when you make a good one, to explain to you when you didn't," said Allebest. "For us, that analysis and unlocking and explaining the game will help people enjoy the game more and help them feel like they're making progress."

In January 2021 alone, Twitch users watched a total of 18.3 million hours of chess

AI is also being built into physical hardware to help beginners pick up the game, much like the portable chess computers of yesteryear. Tatev Abrahamyan is a grandmaster who has competed in the Women's World Team Chess Championships. She's been instrumental in the development of ChessUp, a smart chessboard with a built-in AI instructor. "The AI serves both as an opponent and an assistant, so the users can play against the AI (and choose their desired level) and have an AI assistance when playing another person or the AI," she told *PC Pro*.

"When touching a piece, the board lights up all possible moves according to strength: red is bad, green is best, and blue are OK moves. The users can also adjust the level of the assistance, starting from just eliminating blunders to all the way where they try to find the best possible move according to Stockfish. The board is great for teaching someone how to play, eliminating illegal moves and balancing a game between players of two very different levels."

Speed streaming

Chess's burgeoning popularity is plain to see on the streaming site Twitch. For a brief period at the beginning of 2021, chess overtook games such as *Fortnite*, *Valorant* and *League of Legends* to become the top gaming category by number of viewers. In January 2021 alone, Twitch users watched a total of 18.3 million hours of chess.

The biggest Twitch chess star is grandmaster Hikaru Nakamura, the five-times US chess champion who has 1.3 million viewers on the service. The 34-year-old is mesmerising to watch. He takes on allcomers, playing at a frightening speed, while simultaneously listening to music on his headphones and chatting away with people commenting on his Twitch stream. He knows what other players are going to do about six moves before they do. He is tremendously arrogant, yet somehow personable with it.

Nakamura's game is now all about the speed that the Twitch audience crave. He hasn't played a rated classical chess game for more than two years, but he's won Chess.com's online speed championship for the past four years on the spin, seeing off players such as Carlsen. He was playing in the World Rapid (15-minute games) and Blitz (three-minute games) championships, which kicked off on Christmas Day, "because chess players don't have families or lives," he told his streamers shortly before the event started. He eventually finished sixth in the Rapids, three places behind Carlsen and four behind Nepomniachtchi, and was, well, blitzed in the Blitz (he finished 156th). In his defence, he caught Covid while he was there, although that didn't stop him from spending

BELOW **US chess champion Hikaru Nakamura is a Twitch sensation**

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BELOW The ChessUp kit uses AI as both the opponent and an assistant

the rest of the week streaming in quarantine from his hotel room.

Aside from the speed games, Nakamura and other Twitch chess pros spend a lot of time in puzzle tournaments, where players are given a series of pre-set scenarios and have to find the best move or moves (the kind of puzzle you might find in the back pages of *The Times*). They generally solve the puzzles in a couple of seconds, before most players have even had a chance to evaluate the board. Even in his Covid-addled state, he regularly solved around 45 puzzles within three-minute games.

Death of the long game?

Will the huge audiences for these fast-paced games eventually erode the classical game, in much the same way many believe that formats such as The Hundred and T20 have been detrimental to the quality of Test cricket? "I think there will always be a reverence for the longer, classical game," said Allebest.

However, he added, "we've seen that Chess.com's Speed Chess Championship is such an exciting format and really draws in players because they're playing faster games, Blitz and Bullet, and it's really drawn its own audience. It's so fun to watch and it creates more mistakes, which creates more drama and more fun."

The faster tournaments – and doubtless the prize money and streaming revenue that comes from them – are also more appealing to the players, Allebest claims. "Many of the top chess players have told us that they liked the rapid chess format a lot, because they do feel like the quality's there," he said. "They're also not exhausted spending seven hours on one game that they lose – they can go on and play four games today and have a different experience."

Nigel Short agrees that the new high-speed variants of the game will further encourage the long-term trend of the game becoming faster. "There will always be a place for the classical game, no doubt about that, because it has that gravitas, which the faster variants don't," he said.

"If you look at the history of chess, it has been getting faster and faster. I am of the view that chess is a living thing and you shouldn't allow it to become ossified. I'm somebody who cares about the history of the game," he said, pointing to the 300 or so chess books in the library behind him as we chat on a Zoom call, "but that doesn't mean it should never be tweaked."

Indeed, one tweak that Short is enthusiastically advocating is for stalemate (where the king can't move because every available square is in check) to be declared a victory instead of a draw. "A stalemate is killing the king," he said. "It is something which I think should be revisited. People will look at it because stalemate, as it stands, is making a drawish game more drawish."

What's more, Short argues the AI provides evidence that stalemate should be declared a victory. "Demis Hassabis [the CEO of DeepMind] and AlphaZero have actually looked at changing this rule, and it makes a difference. It doesn't make that much of a difference, but it's a difference, in my opinion, worth having for spicing up the game."

Given AI has been blamed for making the game more boring, it certainly would be ironic if AI evidence is used to pep it up again. ●

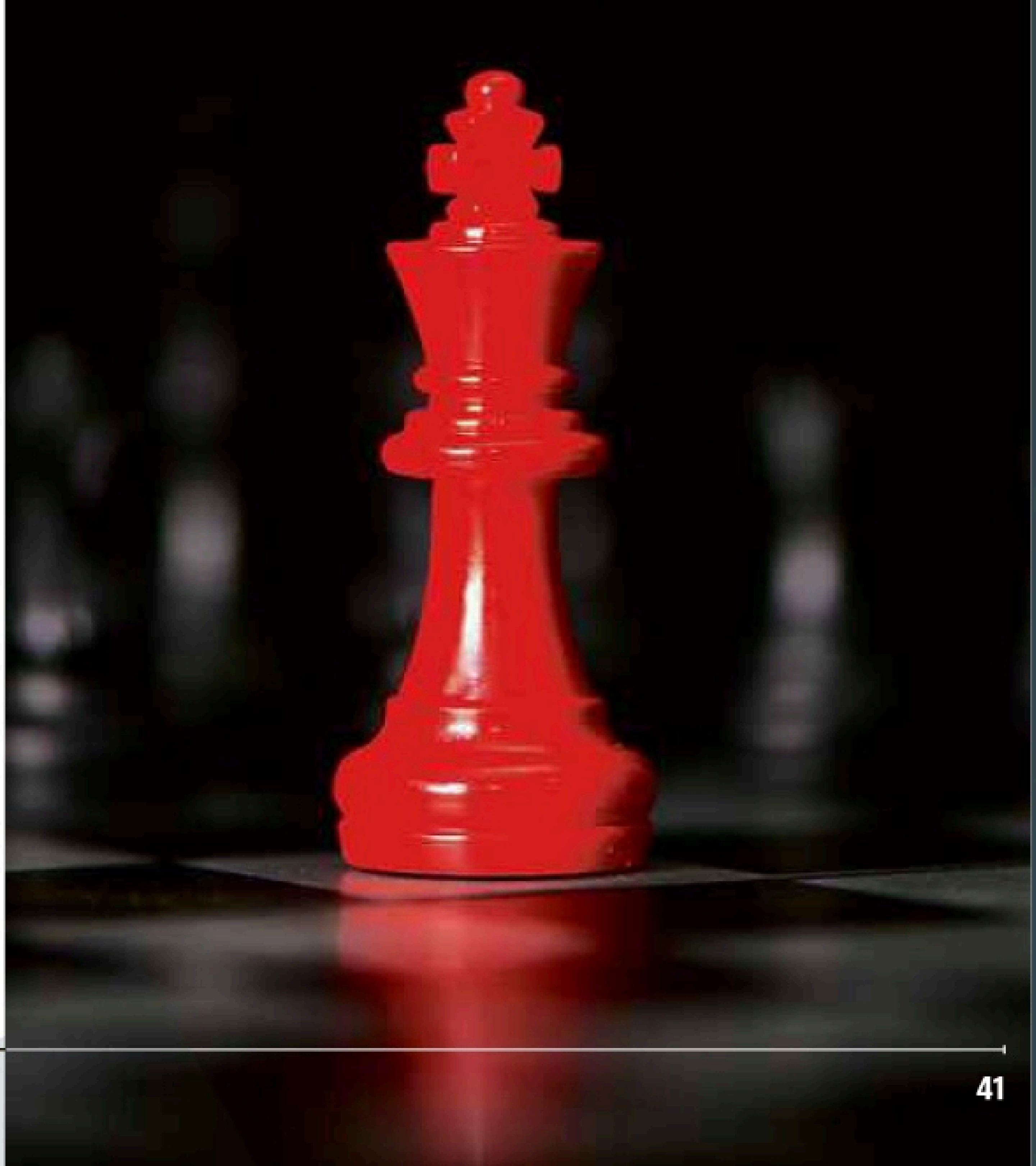
WHAT'S NEXT FOR ALPHAZERO?

DeepMind's AlphaZero has already overcome rival AI engines and inspired grandmasters to change their style of play. So what else is left for AlphaZero to achieve? After all, it's not as if any human grandmasters will be stupid enough to take it on. As Nigel Short remarks, even "your mobile phone will just thrash the world champion" these days.

DeepMind's staff research engineer, Nenad Tomasev, says the project is now focused on giving something back to the chess community. "We are no longer actively improving AlphaZero on chess, to make it stronger," he said. "Instead, we see this as an opportunity to do research on identifying ways in which AIs can best complement and enrich human skill, as this is likely to be important in various domains of future AI applications."

That doesn't mean they've given up on chess entirely. The team are working with ex-world champion Vladimir Kramnik to explore various projects, such as prototyping alternative rule sets for chess. As Nigel Short mentioned, the team has explored including stalemate as a victory as well as more fundamental changes. These include eight other rule changes, such as no-castling, pawns being able to move backwards as well as forwards and the option to capture one's own pieces. The paper exploring the new variants can be found at pcpro.link/330zero1.

A second project is, says Tomasev, "about understanding how AlphaZero learns and encodes chess knowledge, in order to develop ways of accessing pieces of it that could help inform the human understanding of the game". The paper (pcpro.link/330zero2) shows that there is limited overlap between the way AlphaZero learned the game and the way humans do, which could have big implications for the way the game and other concepts are taught by AI.



RUN VoIP AT HOME

The plain old telephone system has had its day. **Nik Rawlinson** explores the benefits of VoIP for home users

The landline is a true relic of a bygone age. The first British fixed telephones were installed way back in the 1870s, and now that almost everyone has a mobile phone, you might think there's no more need for the traditional voice service. Yet many people still like to have a home number, and with increasing numbers of us working remotely it makes more sense than ever to have a second line for business. You might even want an additional "burner line" for use on forms and subscriptions, which you can dump if it starts to attract spam calls.

For situations like this, the most flexible solution is VoIP. Voice over Internet Protocol systems route your calls over the internet, rather than a dedicated telephone line, but they're not like services such as FaceTime and WhatsApp, which only let you connect with other people using the same app. A VoIP call can connect to the standard phone network and reach any number in the world, just as if you were calling from a landline or a mobile.

One very simple way to get started with VoIP is using Skype, which lets you sign up for a personal phone number that can be used to make and receive calls on the regular phone network. Don't limit yourself, though: there's a whole world of dedicated VoIP providers offering packages and apps to suit all needs.

How much could you save?

One obvious reason to choose VoIP over a standard phone line is cost. BT charges £140 to install a new home phone line, or £49.99 if you're simultaneously signing up for an ADSL broadband package. Then there's the line rental to pay: BT's standard line rental is £21.10 a month, although you can reduce this to £18.32 if you opt for Line Rental Saver and pay for a full year's service up front. By contrast, many VoIP providers let you sign up for free and don't charge any recurrent fee for the connection.

Of course, you'll probably want a domestic internet connection to use VoIP, so you may have to keep paying line rental in order to get an ADSL service. Even so, depending on your usage, VoIP can still work out cheaper than many talk packages.

What are the other advantages?

VoIP is ideal for anyone who works from home, or on the move. You can make use of handy features such as call monitoring and a professional-sounding virtual assistant, and you can always receive your calls no matter where your phone is located – either by using an app on your mobile or laptop, or just by hooking up your VoIP-enabled desk phone to any available internet connection. That's not something you can do with a traditional landline, which is tied to the location at which it's installed unless you set up call forwarding for an extra few pounds per month.

If your employer uses VoIP, you can alternatively connect to their internal phone system from your desk at home. This isn't just about being able to forward calls to other extensions: presence and availability features let you stay in touch with your whole team, even if members are hundreds of miles apart. The ability to run services across a mix of desk phones and softphones again gives you agency to work wherever is most convenient, using whichever device suits you.

ABOVE A VoIP-enabled desk phone can hook up to any internet connection
GRANDSTREAM
GXP1620
HD

Managers, meanwhile, like the way that VoIP gives them visibility into what staff are doing, and who they're talking to and when. In some instances, VoIP can be integrated with an organisation's online help or chat solution, effectively centralising several modes of communication within a single interface.

How do you get set up?

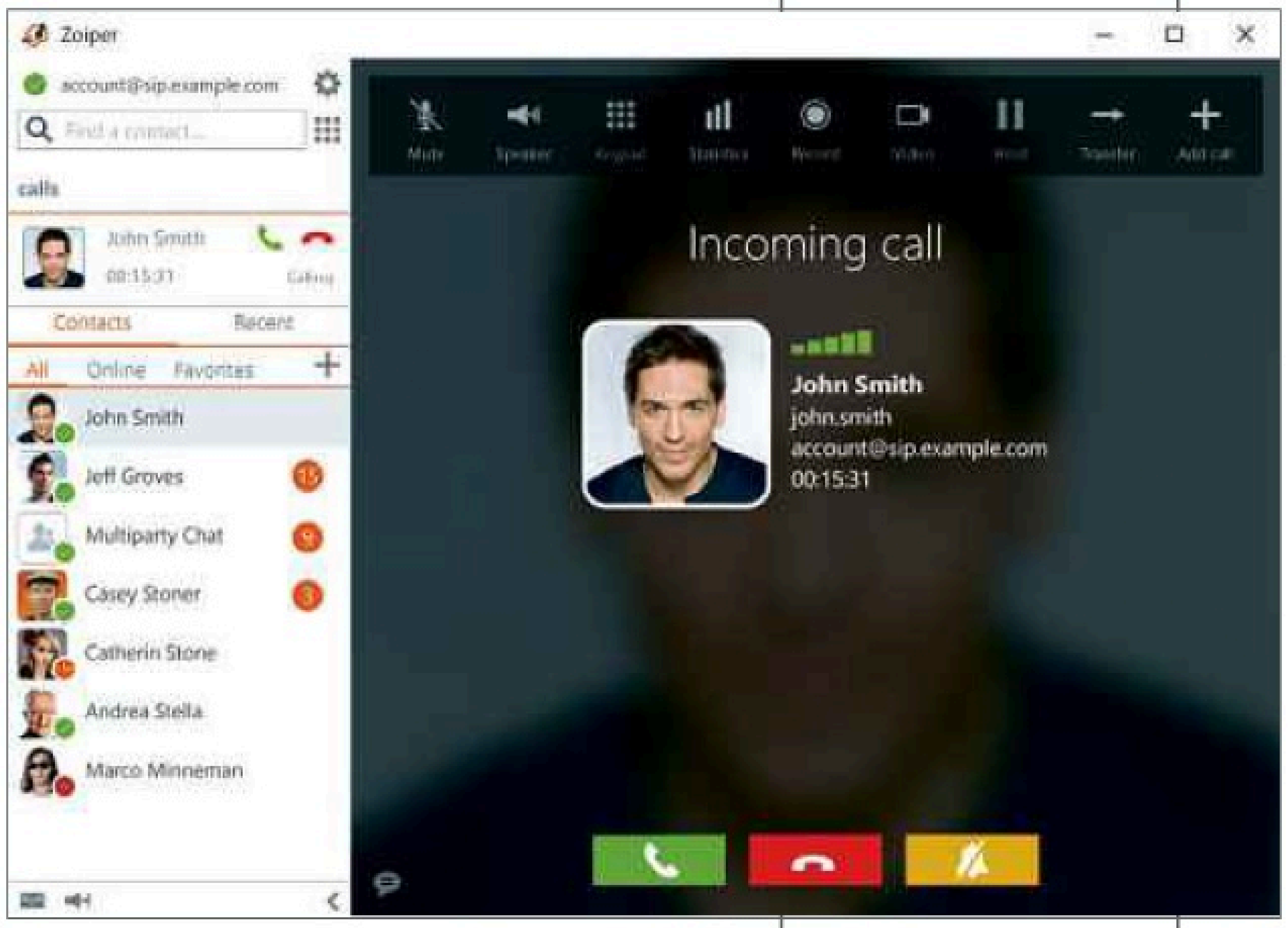
If you have cable internet or a fibre-to-the-premises connection, there's nothing stopping you from having your phone line disconnected entirely, and switching all your voice services to VoIP. You'll enjoy all the benefits of a landline and associated number, plus plenty of

A VoIP call can connect to the standard phone network and reach any number in the world

additional features, while avoiding most of the costs.

Sadly, while cable is now available in just over 50% of homes, full fibre has reached less than a third, so this option isn't open to everyone. If you're on ADSL or fibre-to-the-cabinet, you'll probably need to keep the landline going, although for some people it might be feasible to switch to 4G or 5G mobile broadband as a full-time internet service. Even so, VoIP is still likely to save you money compared to the cost of running one or more standard phone lines.

Most VoIP services use the standard Session Initiation Protocol (SIP) to route calls onto the main telephone network. When you sign up with a VoIP provider, you'll be issued a username and password for the SIP server, which you can then use to set up whichever device or app you want to use for voice calls. For security, there may be one or two extra hoops to jump through: Sipgate (**sipgate.co.uk**) confirms your address by posting you a verification code, which must be entered into the Sipgate dashboard before you can use the service; this means it can take two or three business days to get fully set up.



BELOW **You can use a softphone app such as Zoiper for your calls**

What do numbers and calls cost?

With a regular phone line you normally get assigned a random number that relates to your geographical region. With VoIP you can choose your locale; for example, you could sign up for local numbers in London, Edinburgh, Cardiff and Belfast, each terminating at the same handset in Norwich, to give contacts or customers the impression you have a presence in each of the UK's constituent nations.

Similarly, you can use your UK number when travelling overseas, allowing contacts to get in touch at local rates – and allowing you to avoid expensive roaming charges.

What you pay depends on what you want, and varies for different providers. Sipgate includes a UK local number free with every account, while Localphone (**localphone.com**) charges 90p a month for a UK landline number, plus an additional one-off charge of 90p for set-up. As well as your choice of UK area code, you can register international numbers, giving overseas friends and colleagues a local line to call. Australian numbers are £3.90 a month, plus a one-off £3.90 setup fee; American numbers cost 90p per month, plus £2.40 to set up; and Canadian charges run to £2.40 per month, plus £3.90 to set up.

Once you've got your number, you'll often only pay for your calls. On both Sipgate and Localphone there's no subscription fee – you only pay 1.18p per minute to UK landlines. Localphone charges the same for mobiles, though Sipgate's Basic tariff charges a pricier 9.9p per minute. There are bundles too, starting at £9.95 a month for unlimited calls to landlines and mobiles within the UK.

For comparison, BT's standard rate for calls to UK landlines is 20.9p per minute, while Spain, France and Germany are 18.9p per minute and the USA costs a whopping 62.7p per minute (see **pcpro.link/330callcosts**). You can, however, reduce these charges significantly if you sign up for a call bundle, such as the Friends & Family or International Freedom packages. You can find a full list of BT's charges at **pcpro.link/330bt**.

Desk phone, adapter or app?

It's often most convenient to make and receive calls through a VoIP-enabled desk phone. You can pick up a basic handset for under £50, and connect it directly to your router: one such option is the Grandstream GXP1625, which costs £43 at Amazon (**pcpro.link/330grand**) and supports two simultaneous SIP profiles. It has a small screen, three soft buttons, a 1,000-entry phone book and a 200-entry call log.

There are plenty of more upmarket options. If your budget extends to just shy of £300, the Linux-based Yealink T48S (**pcpro.link/330yealink**) has a 7in colour touchscreen and supports 16 individual SIP profiles. At the back you'll find not only an Ethernet socket but a USB port that can take either a Wi-Fi adapter for wireless operation, or a flash drive that can be used to record calls.

Another option is to invest in an analogue telephone adapter (ATA), allowing you to connect a regular handset to your chosen VoIP service. These start at around £30 and usually sport one or two phone sockets, plus a single Ethernet port for connecting to your router. They rarely have screens, so setup and configuration are performed through a web interface. The Cisco ATA191, which can be had for £58 from **pcpro.link/330cisco**, has two telephone sockets and supports

two individual SIP profiles, allowing you to run a pair of lines through a single box.

Physical handsets provide a simple, familiar way to communicate, and if you're using multiple lines these don't necessarily have to be with the same SIP provider; for example, you could set up an international Localphone number alongside a 3CX (**3cx.com**) line you use for work. Microsoft has also recently announced SIP support for Teams, allowing users with compatible AudioCodes, Cisco, Polycom and Yealink SIP handsets to join Teams meetings directly from a desk phone (**pcpro.link/330teams**).

If you prefer, you can use a softphone app for your calls instead. This is a cheaper and more flexible approach; the downside is that you can only receive calls when the host system is switched on and online. One popular choice is Zoiper (**zoiper.com**), which is available for all the major desktop platforms, and is free for non-commercial use on both Android and iOS with a single SIP account. It's an attractive way to add a second number to a single-SIM phone; additional numbers require a Combo Pack subscription, which costs £10.49 per year or £1.09 per month. As its name suggests, the pack does more than just enable additional lines, adding call recording, transfers, conferencing and additional codecs.

RESET
PHONE 1
PHONE 2
NETWORK
DC 5V POWER

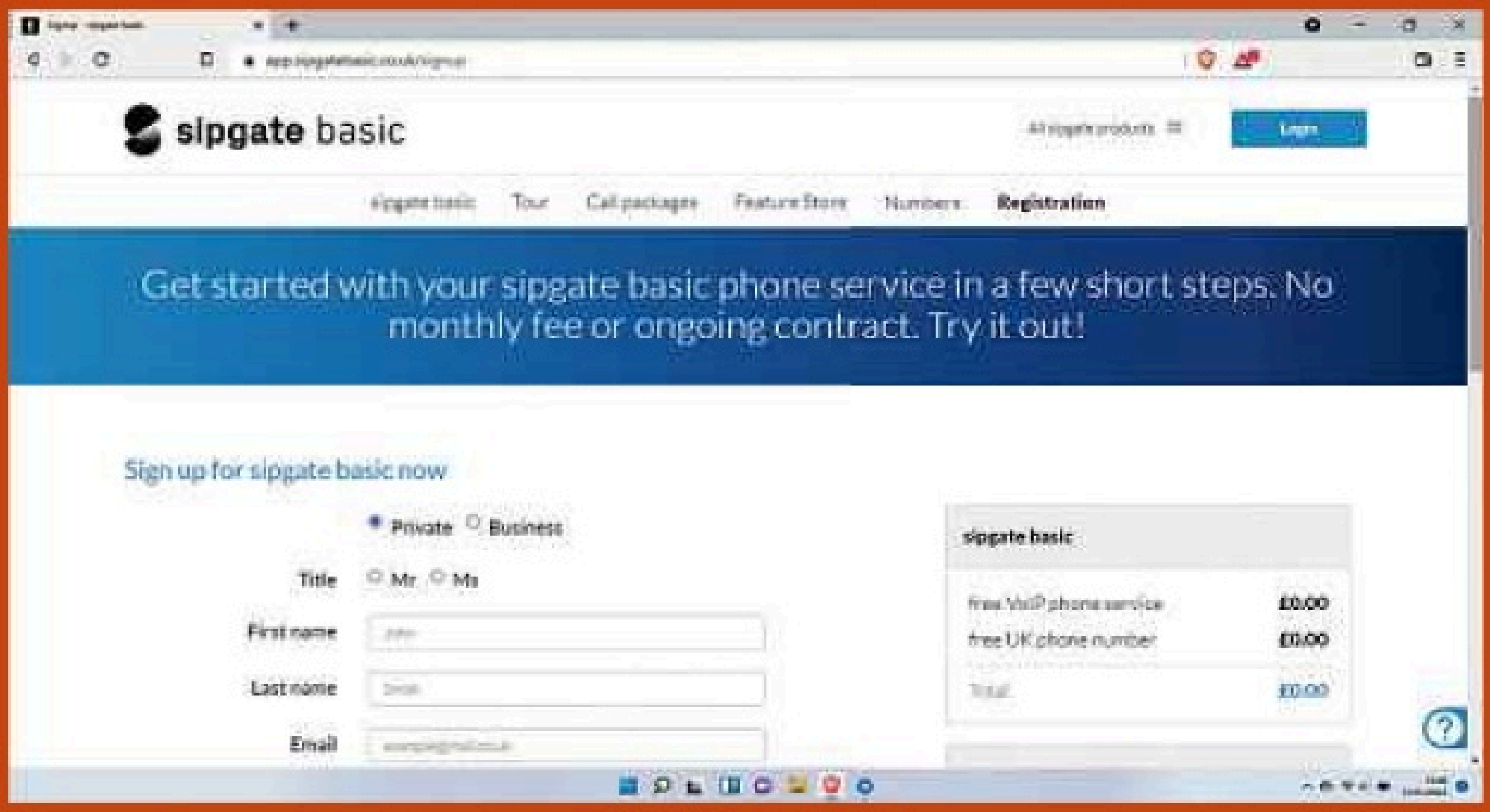
ABOVE The Cisco ATA191 lets you run two lines through a single box

Can you connect other devices to your line?

Yes, so long as your adapter and SIP provider support them. Some analogue phone adapters, such as the £43 Grandstream Handytone HT801, (**pcpro.link/330handy**) can receive faxes. But, to avoid disappointment, check with your VoIP provider that it also supports fax transmission.

If your home alarm system is set up to issue remote alerts, it may also be possible to use an adapter to route the call over the internet. Remember that your VoIP system needs an internet connection, so if there's a power cut it won't be able to raise the alarm. That's one situation where a regular landline has the advantage: the phone network uses its own power supply, and doesn't rely on the mains, so it can normally carry on working when everything else is blacked out. ●

Setting up VoIP at home with Sipgate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Call packages
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Numbers
Registration

Get started with your sipgate basic phone service in a few short steps. No monthly fee or ongoing contract. Try it out!

Sign up for sipgate basic now

○ Private ○ Business

Title ○ Mr ○ Ms

First name

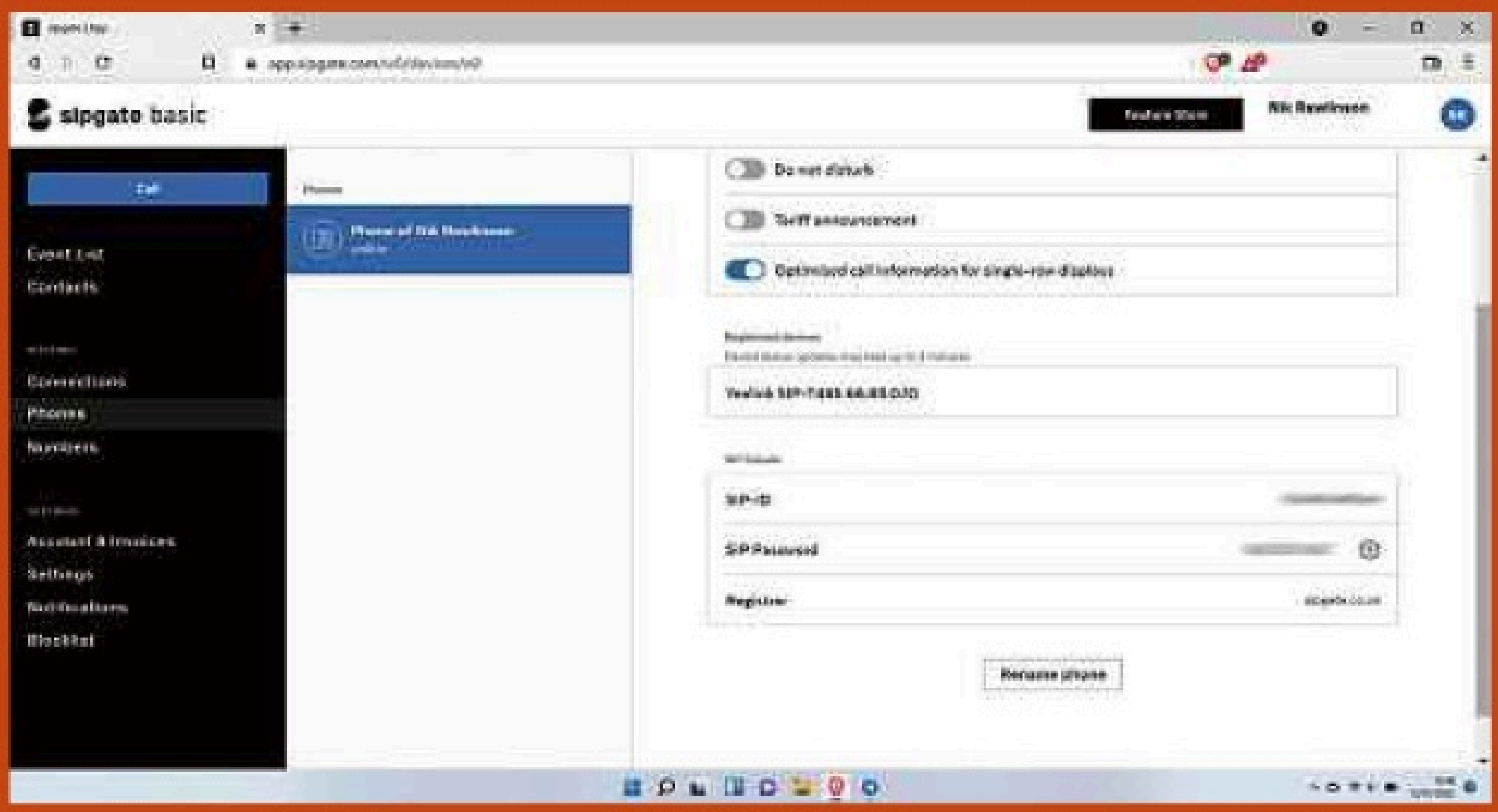
Last name

Email

sipgate basic	
free VoIP phone service	£0.00
free UK phone number	£0.00
Total	£0.00

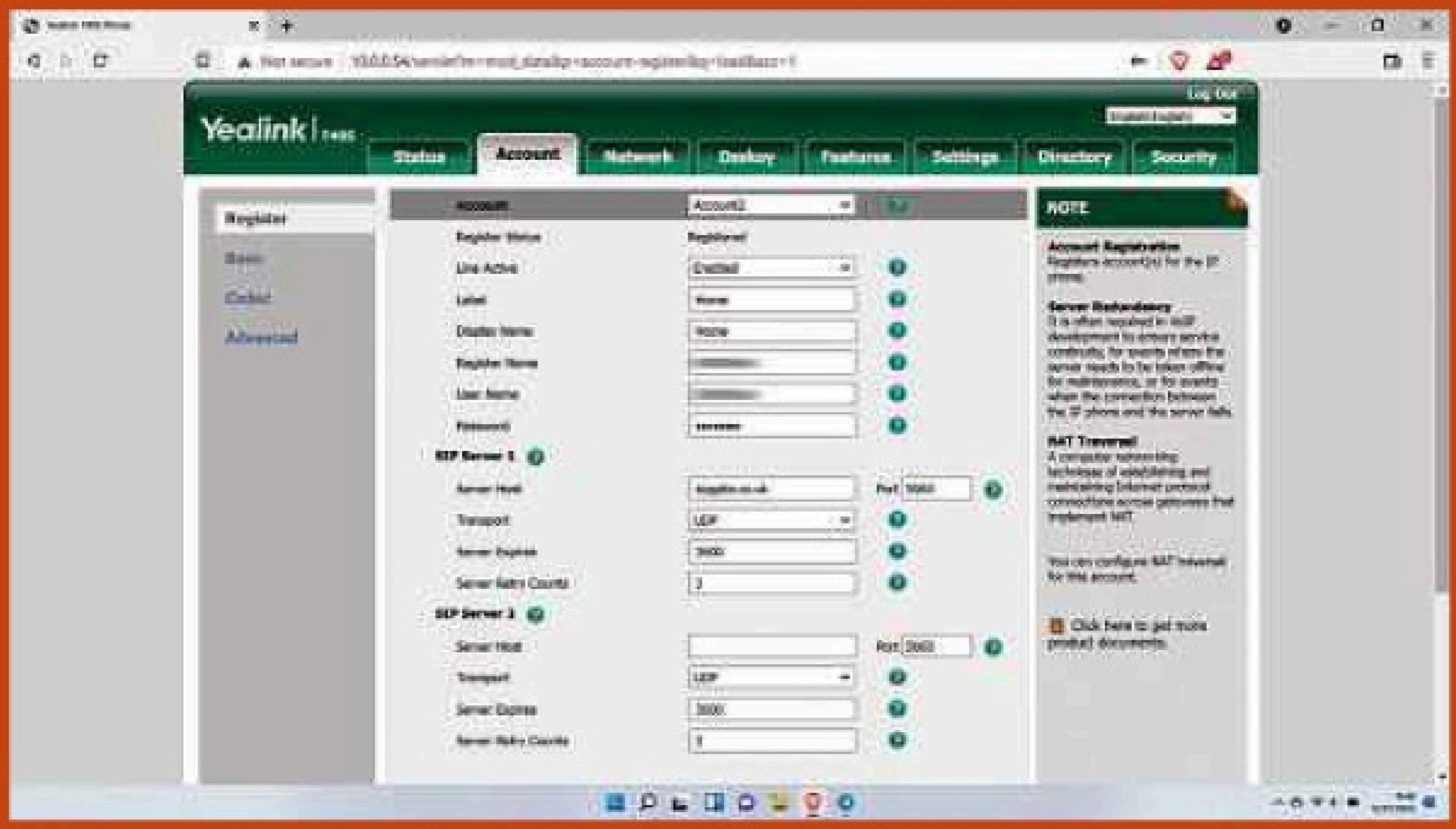
Signing up for a Sipgate account

Open a new tab and point your browser at sipgate.co.uk. Click 'sipgate basic', followed by 'Sign up for free now'. Work your way through the registration form, providing the necessary information. As part of the sign-up process, Sipgate will send a link to your inbox. Click it to verify your address, then provide your address details and date of birth, and choose the number you'd like to use with your desk phone or smartphone.


sipgate basic
Feature Store
Call
Event List
Contacts
Connections
Phones
Numbers
Account & Invoices
Settings
Notifications
Blocklist
Do not disturb
Tariff announcement
Optimized call information for single-row displays
SIP-ID
SIP Password
Registrar
Rename phone

Retrieve your account details

When your account is up and running, log in at sipgate.co.uk. You'll be redirected to your account dashboard, where you can top up your call balance and check a log of your incoming and outgoing calls. This is also where you can set up your voicemail and opt in to a calling bundle by clicking the Feature Store button. For the moment, click Phones in the sidebar, then scroll down to SIP Details in the right-hand pane.

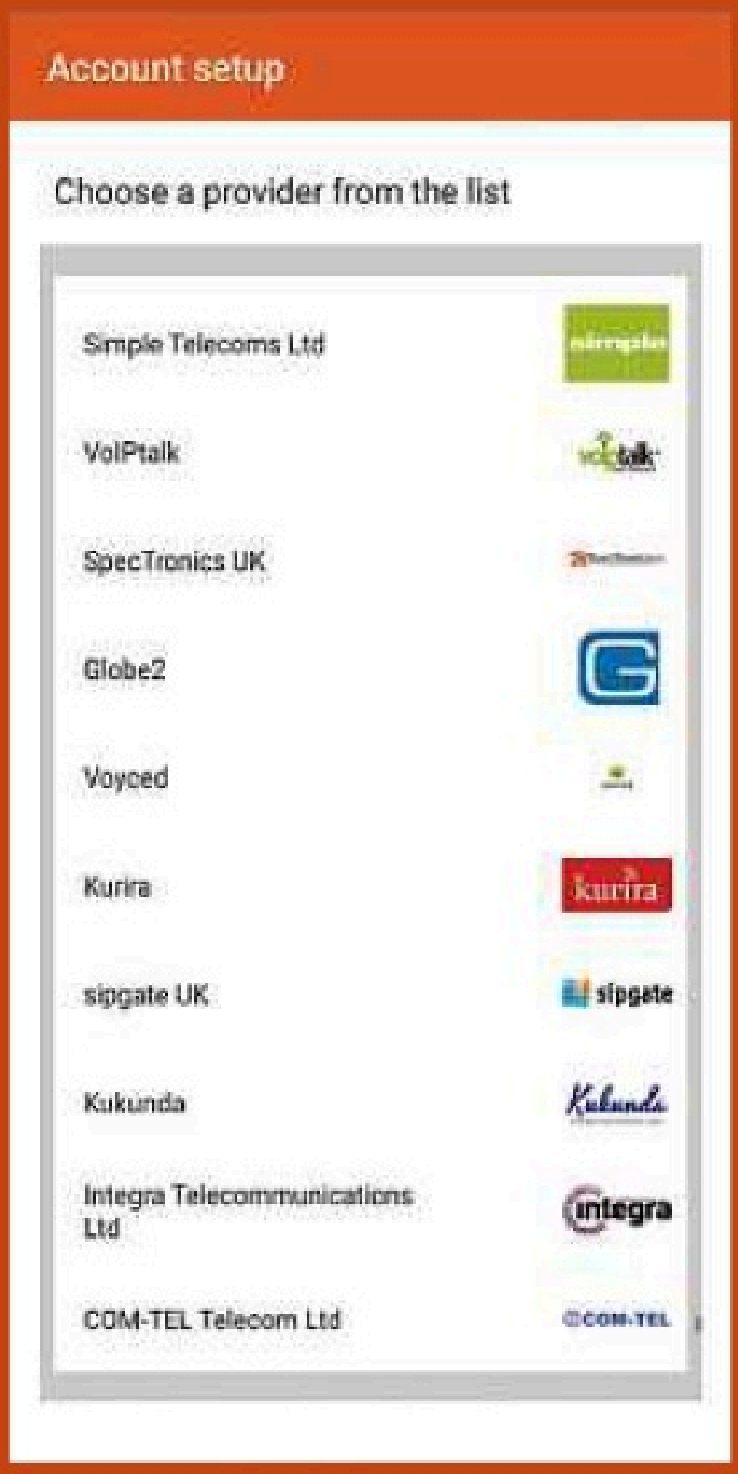

Yealink
Status
Account
Network
Dsskey
Features
Settings
Directory
Security
Register
Basic
Codec
Advanced
NOTE
SIP Server 1
SIP Server 2

Set up your desk phone

Find your desk phone's IP address in your router's list of connected devices, then type it into your browser. Log in to the phone admin pages, and head for the line, account or SIP profile settings. You'll need the SIP-ID, SIP Password and Registrar details from your Sipgate dashboard, the latter of which is the both the primary server host and the outbound proxy server. Apply the settings you've entered, and your phone will connect to your account.

Using VoIP on your smartphone

Install Zoiper from Google Play or the iOS App Store (pcpro.link/330zoiper) and, on the opening screen, tap 'Providers list', followed by Next. Tap United Kingdom, followed by 'Show more', then scroll down to and tap Sipgate UK. Tap 'Get configuration', then type the SIP-ID and SIP Password from your Sipgate dashboard into the Username and Password fields. Tap OK, and when Zoiper asks permission to make and manage phone calls, tap Allow. Also allow it to run in the background when requested.


Account setup

Choose a provider from the list

- Simple Telecoms Ltd
- VoIPtalk
- SpecTronics UK
- Globe2
- Voyced
- Kurira
- sipgate UK
- Kukunda
- Integra Telecommunications Ltd
- COM-TEL Telecom Ltd

BATTERY TECHNOLOGY EXPLAINED

Darien Graham-Smith explores the myths and mechanics of modern batteries

We all know how to use a rechargeable battery. You plug it into the mains to charge it up; then you can use that charge to power a phone, laptop or other device until it runs out. But what's actually happening inside the battery? And how do you keep a modern lithium battery working safely and efficiently for as long as possible? Here's what you need to know about those little power packs that keep everything ticking over.

What's the charge?

As a rule it's best to keep liquids well away from your electronic devices, but most batteries actually contain a liquid substance called an electrolyte. This is the chemical that stores the battery's charge, and it's internally divided into two compartments by a thin physical separator.

We won't get into the details of the chemistry here, but simply put, charging the battery pushes positively charged ions through the separator, from one side of the electrolyte to the other. When the current stops, the charge can't pass back across the separator, so the battery ends up with one positively charged end and one negatively charged end. These opposing ends are connected to two external terminals – the anode on the negatively charged side and the cathode on the positively charged side – and when these are connected to an electrical circuit, electrons flow from the anode to the cathode, balancing out the charge and powering any components they pass through along the way.

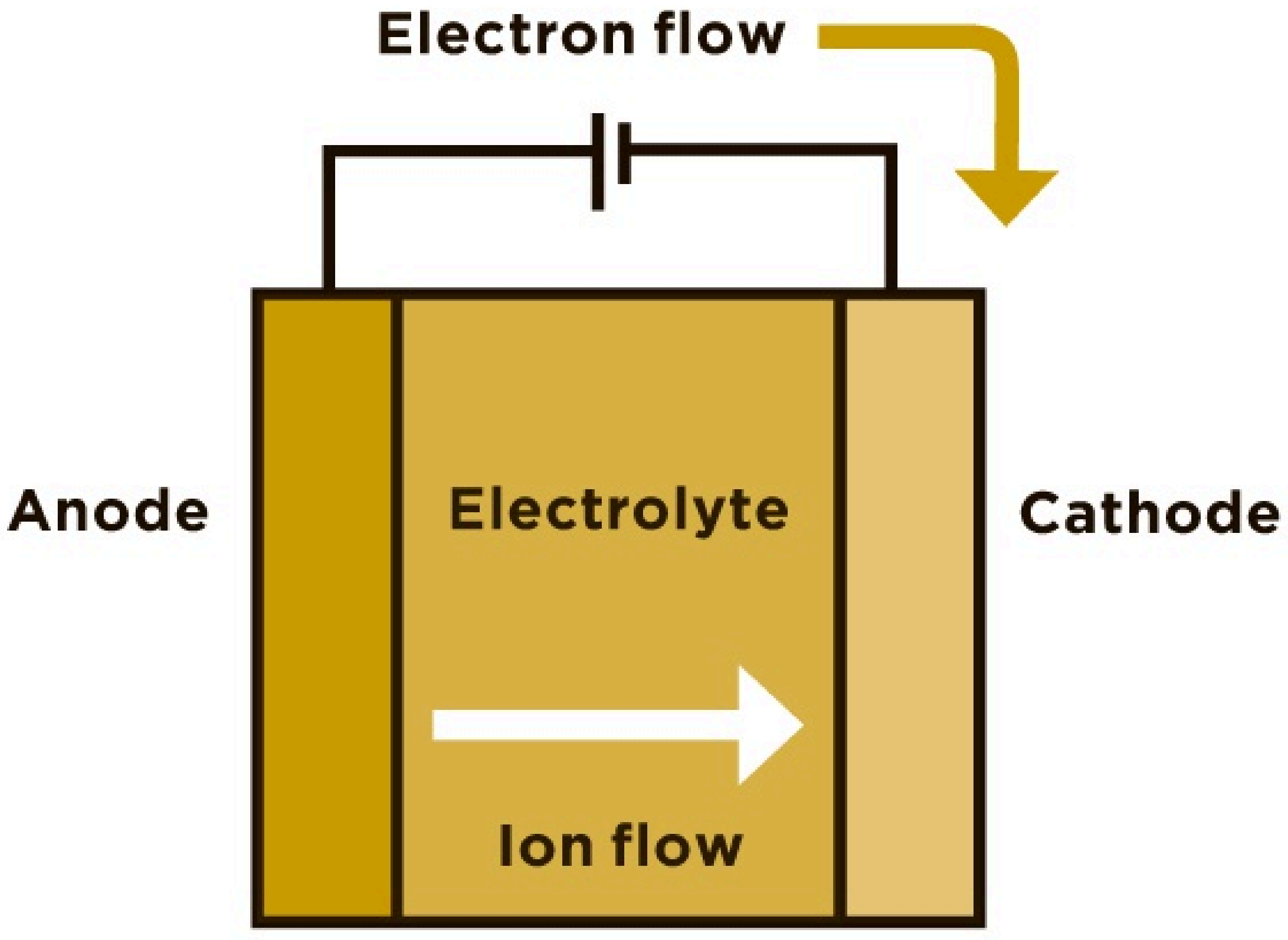
Over time, the electrolyte gradually breaks down, causing the battery to perform worse and worse over subsequent recharge cycles. Depending on the particular chemicals used, though, a battery can be good for hundreds of thousands of recharges.

What are the chemicals?

The first popular rechargeable batteries worked through the reaction of lead and sulphuric acid. The process was discovered back in 1801, and believe it or not it's still used today for car batteries, because these chemicals are able to produce a large burst of power, which is ideal for starting a vehicle.

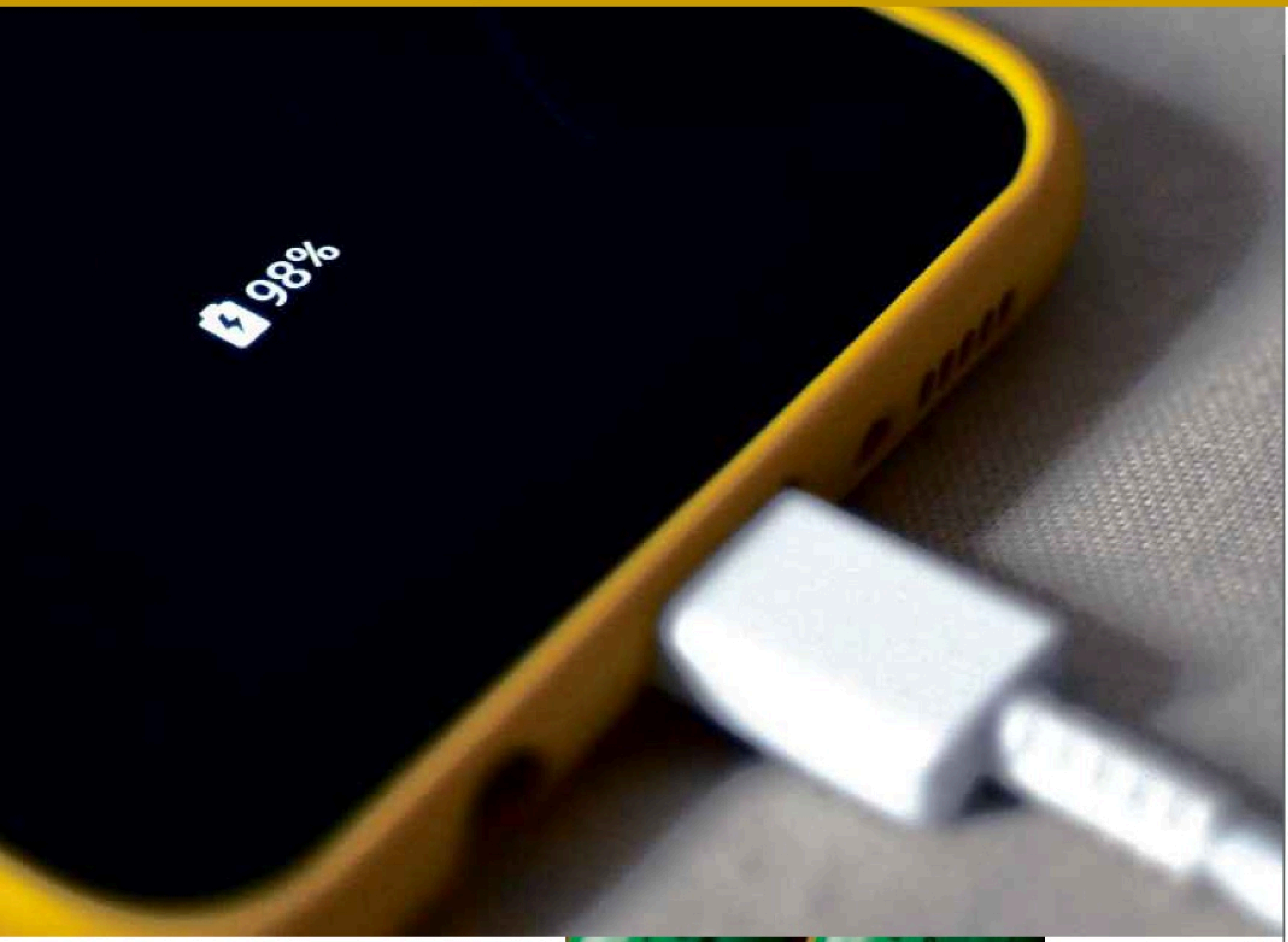
In the 20th century, nickel-cadmium batteries became popular, as they could store more power than a lead-acid battery and could be made to the same size and power standards as the regular batteries used by consumer appliances. The downside of this chemical is that cadmium is highly toxic, making it an environmental hazard to produce and dispose of.

BELOW **Batteries work by moving charge between the opposing sides of an electrolyte**



Nickel-cadmium batteries also suffer from the dreaded "memory effect", which causes them to stop working before they're fully discharged. It's popularly believed that this is caused by repeatedly recharging a battery before it's fully exhausted, so it "remembers" a certain level of minimum charge. In reality, it's normally caused by overcharging, which damages the battery's internals and causes the voltage to drop off as the battery discharges. Technically speaking, the battery still works, but as the voltage falls it loses the ability to power an appliance long before it runs out of charge.

Nickel-cadmium technology was largely replaced in the 1990s by nickel-metal-hydride. Instead of cadmium, this type of battery uses an alloy of multiple metals – different manufacturers have used different combinations – so it's much safer. However, it can still suffer from the same type of voltage drop-off when overcharged, and it also has quite a high rate of self-discharge: if you fully charge up a NiMH battery then set it aside unused, it can lose as much as 15% of its charge per month.



The advantages of lithium

The first commercial lithium-based battery was produced in 1991 as a joint development of Japanese electronics giant Sony and chemical company Asahi Kasei, and since then it's grown to become the universal standard for consumer devices.

Lithium-ion batteries have several advantages over nickel-based designs. They self-discharge much more slowly, and they don't suffer from voltage depression at all. What's more, modern models include a power-management circuit that won't allow you to overcharge them; this does push up the price, but it means you can leave your devices plugged in all day and all night, and the charging circuitry will automatically shut off the power when the battery is full, periodically turning it back on again as needed to keep the charge topped up. You never need to worry about a lithium battery succumbing to the fate that afflicted so many nickel-based batteries over the years.

Sadly, the feared memory effect casts a long shadow, and to this day there's a widespread notion that rechargeable batteries should be completely discharged before recharging. In fact, with lithium batteries the opposite is true. For one thing, if you want your battery to retain its maximum capacity for as long as possible, you should be using it as little as possible – which means plugging in whenever you can, rather than continually emptying and refilling its charge.

Ni-MH
Ni-MH
HARGE

LEFT Nickel-metal-hydride batteries rapidly lose charge over time

Moreover, completely draining a lithium battery isn't good for the electrolyte. Of course, it's not always possible to get to a charger before your phone dies, but regularly running the battery down to zero will degrade its capacity much more quickly than if you recharge at the 20% mark.

Is it true that lithium-ion batteries can explode?

The word "explode" might be a bit of an exaggeration, but it is possible for a battery to spontaneously catch fire. Needless to say, this shouldn't happen under normal circumstances, but if the structural integrity of a battery is damaged, it's possible that the two oppositely charged sides of the electrolyte could come into direct contact, creating a short circuit.

The result of this is a runaway reaction as all the charge floods through the electrolyte at once, causing it to very quickly become very hot. Since a lithium-ion battery contains both oxygen and flammable solvents, the likely outcome is that the thing will literally burst into flames.

This is what happened with the infamous Samsung Galaxy Note 7, released in August 2016. When the battery got warm, the chemicals inside expanded slightly, which could cause the casing to bend, allowing the separated parts of the electrolyte to touch and catch fire. Samsung acknowledged 35 reports of battery defects in the phone's first two months on sale, at which point it famously recalled and discontinued the phone.

It's an alarming tale, and the truth is that any battery could combust in a similar way if it's allowed to overheat or is bashed about. However, it seems that the industry has taken note and stuck with safer battery designs – and we've also seen a move towards lithium polymer designs.

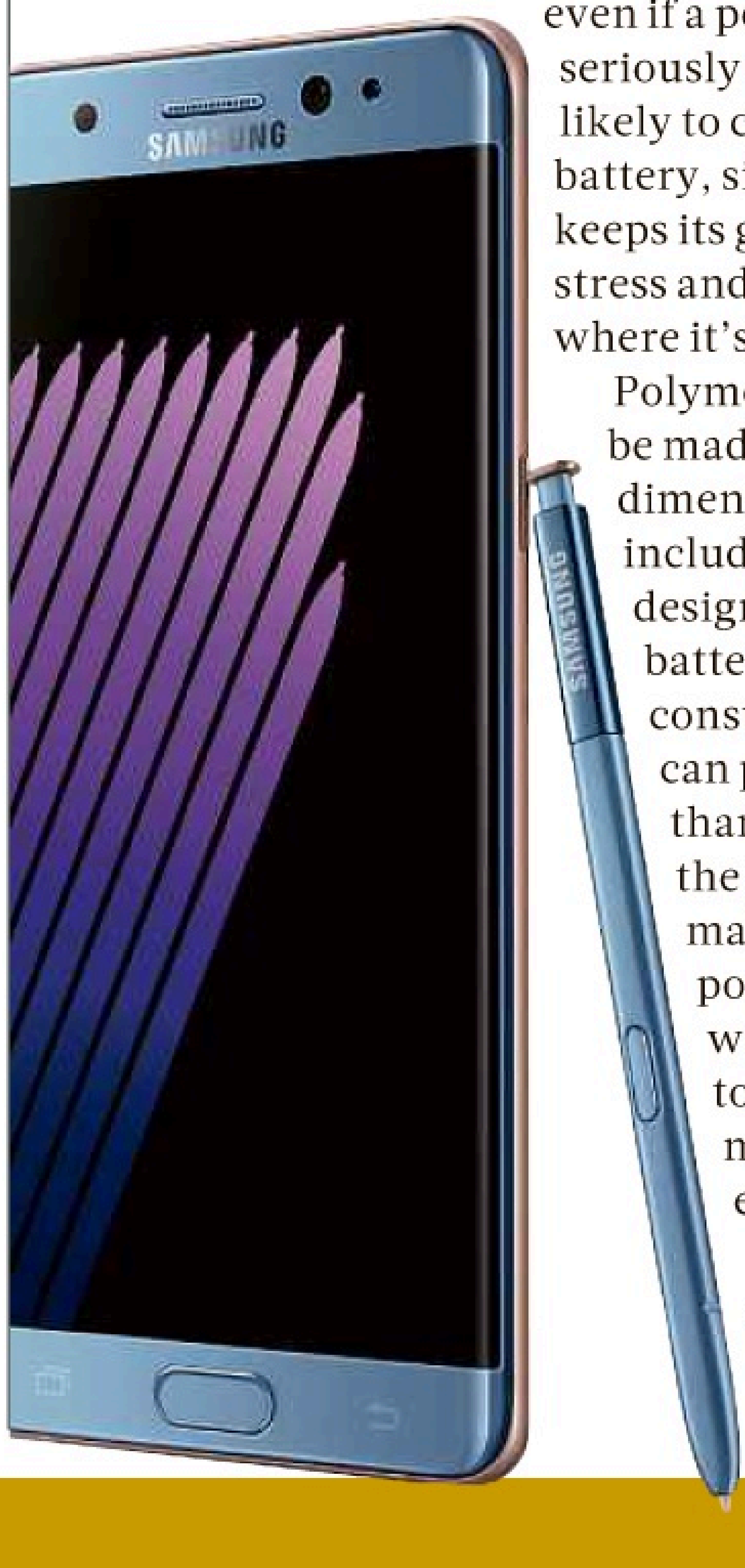
What's lithium polymer?

Functionally speaking, a lithium-polymer battery works exactly like a regular lithium-ion one. The difference is that the electrolyte in a typical Li-ion battery is in liquid form, whereas a polymer electrolyte has a more gel-like consistency. You can often recognise a polymer battery because its body is contained in a pouch rather than a hard case.

One big advantage of this is that even if a polymer battery is seriously damaged, it's far less likely to combust than a liquid battery, since the electrolyte keeps its general shape under stress and can't leak into places where it's not meant to be.

Polymer batteries can also be made to more or less any dimensions desired, including extremely thin designs, whereas liquid batteries are more constrained. And polymer can produce more charge than a liquid equivalent of the same weight, which makes it ideal for portable electronics where it's desirable to keep bulk to a minimum (as well as electric vehicles).

There are some drawbacks to polymer batteries, though. They're more



BELOW The Galaxy Note 7 smartphone fuelled fears about exploding batteries expensive to manufacture than regular Li-ion batteries, and they don't last as long before their capacity starts to drop off. What's more, as they near the end of their usable lifecycle they're liable to expand and bloat, which can damage the device they're housed within.

What other problems are there with batteries?

All types of battery share one big limitation, and that's finite capacity. It would be great if your iPhone could run for a week or a month on a single charge, but sadly it's a hard fact of chemistry that a certain mass of a certain chemical can only store a certain amount of charge. The only ways to get more juice are to improve efficiency, find a better electrolyte or fit a bigger, heavier battery (which is generally the opposite of the design goal).

Needless to say, there's a huge amount of ongoing research into next-generation batteries, including some promising developments using graphene (see below). But for now, this isn't a problem that can be solved by simply investing more funding or engineering muscle.

That's not the only problem. Lithium batteries don't self-discharge quite as heinously as NiMH batteries, but the charge in an unused battery can still drop by as much as 5% per month – which sadly means you can't just leave a fully charged phone in your glove compartment in case of emergencies.

Temperature and degradation

Another major limitation of current battery technology is temperature sensitivity. You'll remember from O-level chemistry that chemical reactions work best at high temperatures. If your battery gets too cold, the reaction inside the battery may slow down to the point where it's not circulating enough charge to power your device: speaking from personal experience, I've had my smartphone switch off spontaneously on a ski lift.

Conversely, if the battery gets too hot, the reaction will take place faster than is needed, and the power will run out more quickly. This is annoying at the time, and it can have long-term consequences, causing the electrolyte to degrade and permanently lose capacity. Different manufacturers recommend different temperature ranges for their batteries; as a rule of thumb,you'll do best if you can keep your battery between 10°C and 45°C. That may sound easy, unless you live in Death Valley, but remember that the inside of a laptop or smartphone may be a lot hotter than the ambient temperature, especially if you're working it hard in direct sunlight.

ABOVE Drivers know temperature can affect battery performance

BELOW Using graphene makes batteries less flammable

NE
Nanotech Energy
Advanced Li Ion Battery

Even if you're careful with your climate control, you can't avoid battery degradation, as the recharging process itself gradually wears down the chemicals. The precise effect depends on the particular design of the battery and charger; for iPhones, Apple suggests that the internal battery should retain up to 80% of its original maximum capacity after 500 full charging cycles. Note the word "full" – if your battery isn't completely exhausted when you plug it in, then that only counts as a partial cycle, and isn't as damaging.

Is fast charging safe?

Since battery capacity is limited, it's desirable to make recharging as quick as possible. Many consumer devices now support fast charging, taking advantage of the fact that a USB-C connection can carry up to 100W of power, while old-school USB cables are limited to 2.5W. This allows you to blast more power into a battery and refill it much more quickly.

If you're thinking about the chemistry of this, however, alarm bells may be ringing: speeding up the recharging process seems like it would accelerate battery degradation.

BELOW Polymer-based batteries can swell and damage their housing

In principle this is true, but you don't need to worry about it too much. When you look at manufacturers' claims for fast charging modes, you'll notice that they never talk about how long it takes to completely refill the battery – for example, Apple advertises that an iPhone can be fast-charged to 50% in 30 minutes. That's because the highest wattage is only used when the battery is mostly empty, and can easily take the charge. As the charge increases, the charging circuitry automatically reduces the power to ensure the battery doesn't overheat or become overloaded. As a result, charging from 50% to 100% will probably take much longer than half an hour – but at least it won't kill the battery.

What's next for battery tech?

While battery technology doesn't progress as rapidly as CPU speeds or hard disk capacities, there are some promising developments in the pipeline. One is new lithium-sulphur designs, which use cathodes made of sulphur instead of cobalt and can store up to five times as much energy as a regular Li-ion battery. However, there are longevity issues with such batteries that evidently aren't easy to solve: back in 2015 Sony announced plans to introduce Li-S technology within five years, but since then it's been noticeably silent on the matter.

Another material that can improve battery performance is graphene – a flat carbon lattice that's just one atom thick. Since graphene is exceptionally conductive it can be used to reduce the resistance of the electrodes, allowing more energy to be converted to useful charge, with less wasted as heat. Graphene-enhanced batteries are already starting to appear – the Elecjet power bank popped up on Indiegogo last year (see **pcpro.link/330elecjet**) and Nanotech Energy earned a CES Innovation Award this year for its non-flammable design.

Longer-term, graphene could also replace lithium in the core of the battery. Kilogram for kilogram, graphene can hold more than five times as much energy as lithium, it can charge much more quickly without major degradation, and its physical nature makes it ideal for ultra-thin designs. Right now, graphene is too expensive to use in consumer batteries, but numerous companies are working on mass-production solutions. In ten years' time, graphene could be powering all types of device, from tiny IoT sensors to watches, phones, laptops and even big electric vehicles. ●

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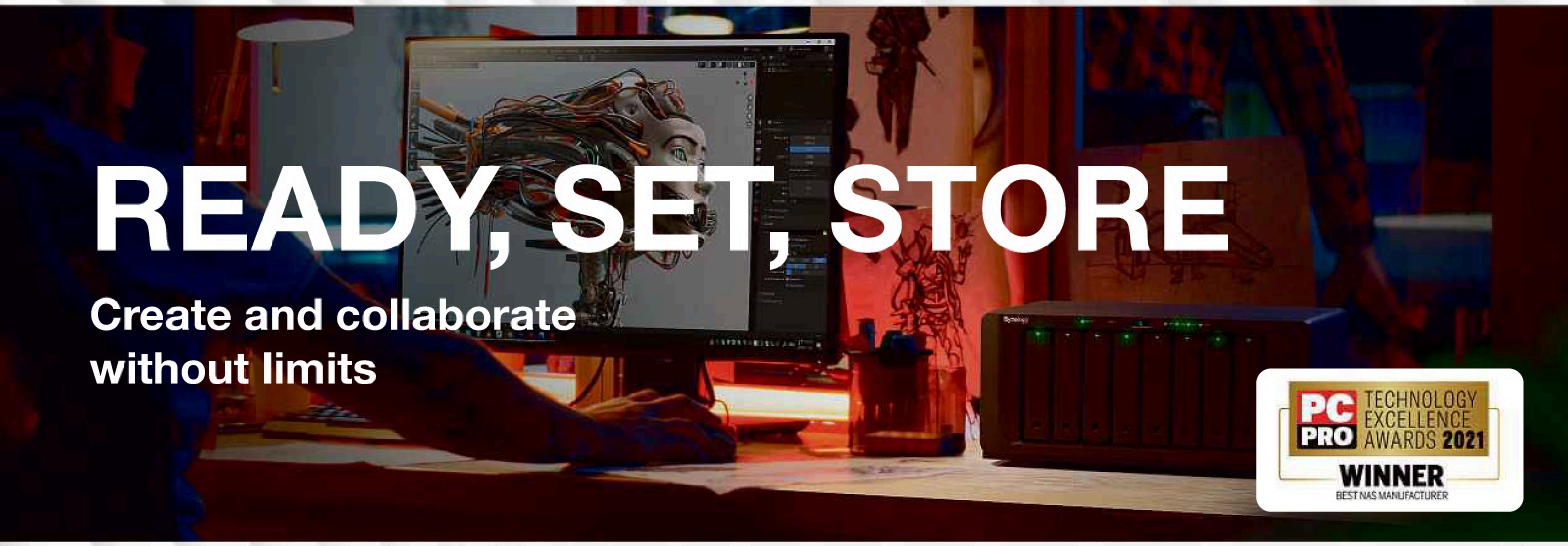

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DS1621+ AT A GLANCE

Synology DiskStation DS1621+ is a powerful 6-bay network-attached storage solution designed to store and protect critical data assets. The growing amount of unstructured data requires smarter and increasingly higher performance methods of storing, accessing, and sharing.

DS1621+ is a compact desktop form-factor NAS that is beyond evolutionary, featuring over 110K,or 174% higher 4K random read IOPS, compared to its predecessor.

DS1821+ AT A GLANCE

Synology DiskStation DS1821+ is a powerful 8-bay network-attached storage solution designed to store and protect mission critical data. Designed to tackle increasing amounts of unstructured data, the low-noise desktop form-factor of the DS1821+ is built for both SOHO and SMB environments.

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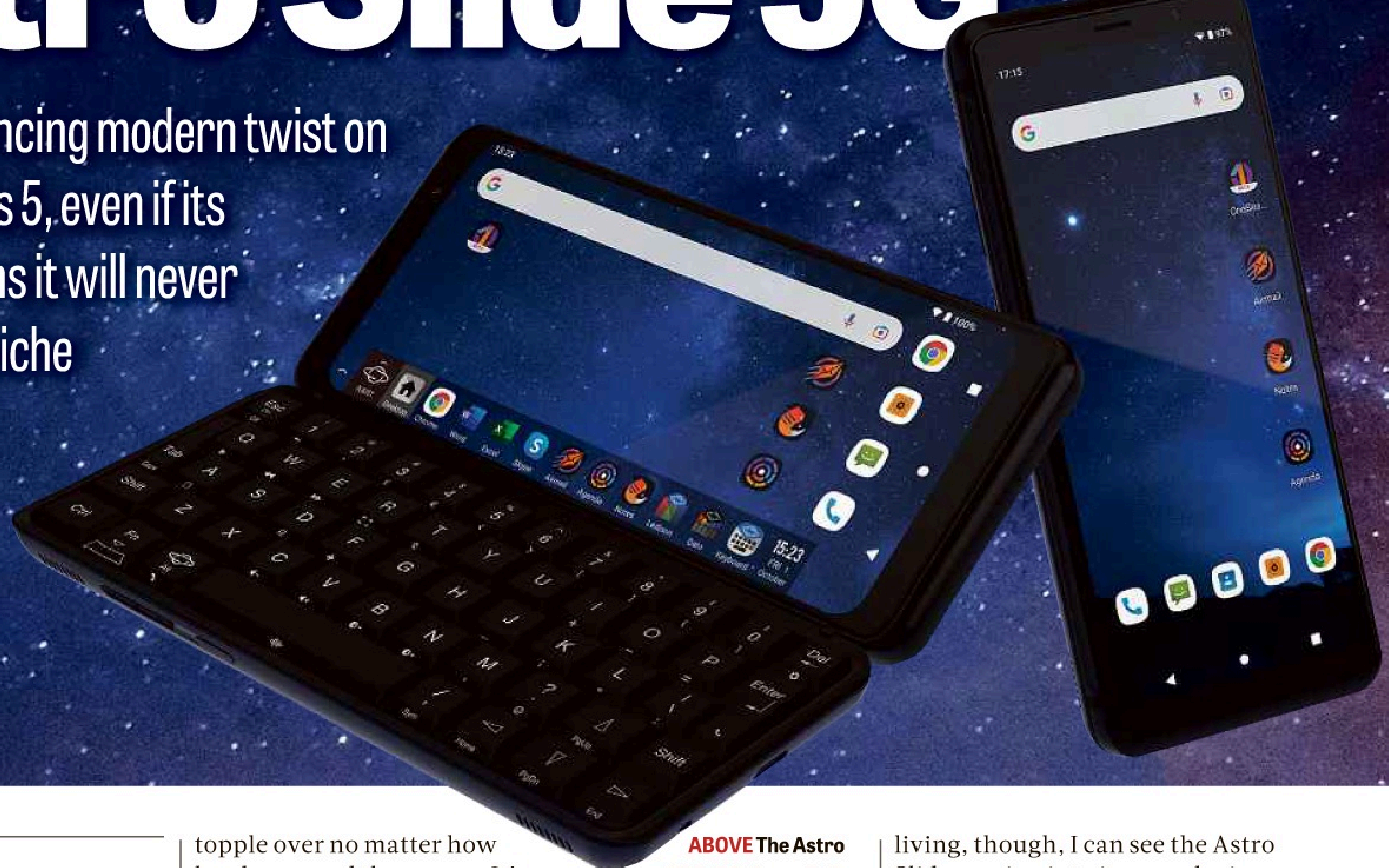
Astro Slide 5G

The most convincing modern twist on the Psion Series 5, even if its thickness means it will never break out of a niche



SCORE ★★★★☆

PRICE £599 (£719 inc VAT) from store.planetcom.co.uk

When London-based Planet Computers launched its Indiegogo campaign for the Astro Slide 5G, way back in March 2020, it struck me as ambitious. Both of the company's previous products, the Gemini PDA (*see issue 285, p58*) and the Cosmo Communicator (*see issue 303, p46*), were clamshell units that essentially updated the Psion Series 5 for the smartphone era, but the Slide takes a cue from the legendary Nokia E7 by using a sliding mechanism to reveal the mechanical keyboard. A tough trick to pull off.

On your first go with the Slide, you may wonder if Planet has met its match: the process can seem wobbly. However, you'll soon learn to either push upwards with both thumbs on either edge or confidently grab it from the middle. Once in place, the screen doesn't move a jot as you type. What's more, thanks to some devious weight management, it will never topple over no matter how hard you prod the screen. It's a great piece of design.

Key victory

I'm also a fan of the keyboard itself, which is the closest yet in terms of feel to the Series 5 original. Arguably it's an improvement, as it also features a multi-level backlight, while a blue LED lights up if caps lock is applied. As a nice extra touch, the keys are now rounded in the four corners of the device, helping to maximise the use of space.

As with all such keyboards, you can't expect to reach the same speeds as on a full-size alternative. I tested myself over the course of two weeks and the best speed I attained was 37 words per minute. That's about half my usual pace and roughly the same as I reach on a Swyft keyboard on an Android phone, but the advantage the Astro Slide holds over predictive input is when entering non-standard text, such as code.

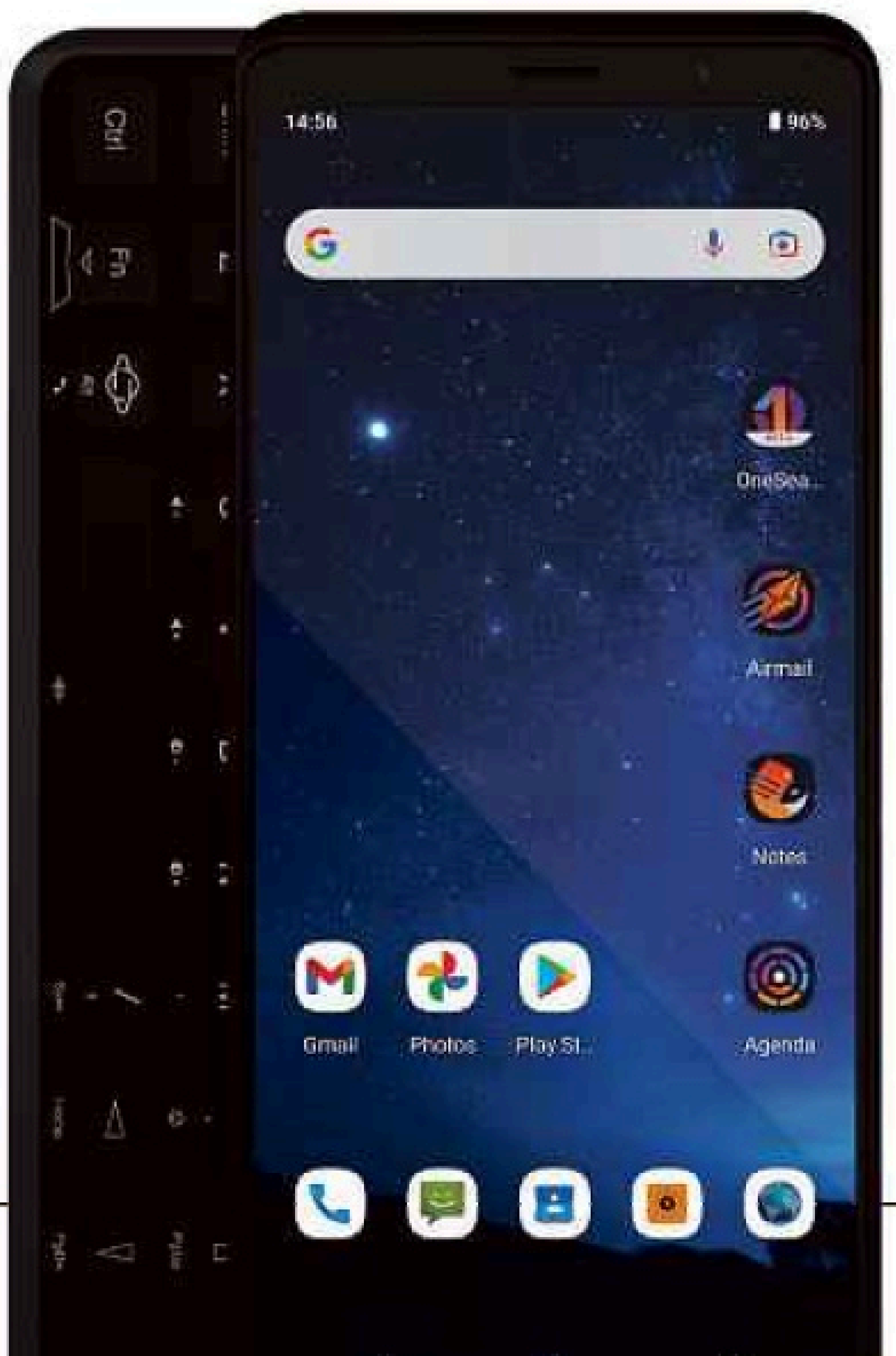
The inevitable limiting factor is the width of the device. My wrists didn't enjoy the cramped typing position for more than 15 minutes at a push. As someone who writes for a living, though, I can see the Astro Slide coming into its own during edits. It allows you to prod on the screen and jump in at the exact point you want to make amends, and the process is quicker and less fiddly than on a standard phone.

ABOVE The Astro Slide 5G channels the Psion Series 5's energy

Getting physical

With the Astro Slide, you also benefit from Planet Computers' years of learning through developing two similar products. For instance, it's well worth teaching yourself the keyboard shortcuts as these will save you time, even when in Android. Fn+D reveals the desktop, for example, while pressing the planet icon brings up a macOS-style dock of your favourite apps.

BELOW The keyboard slides out from behind the AMOLED screen



Then there's the OneSearch application, which couldn't be simpler to activate: from the Android home screen, start typing on the keyboard and search results instantly appear. For instance, type "astro" and a selection of links appear that you can tap on, from pre-filled Google searches to shopping results on Amazon. OneSearch also brings up local matches, so typing a name will reveal contacts that you can tap on to bring up their details (or click on the email, message or dial icon next to their name).

Planet Computers also supplies a polished email app, a note-taking app and a calendar that should integrate with any Duo, Google or Exchange accounts you specify. However, I couldn't persuade the Astro Slide to synchronise with my default Google account or add any others, so I was either unlucky or some extra dev work needs to happen.

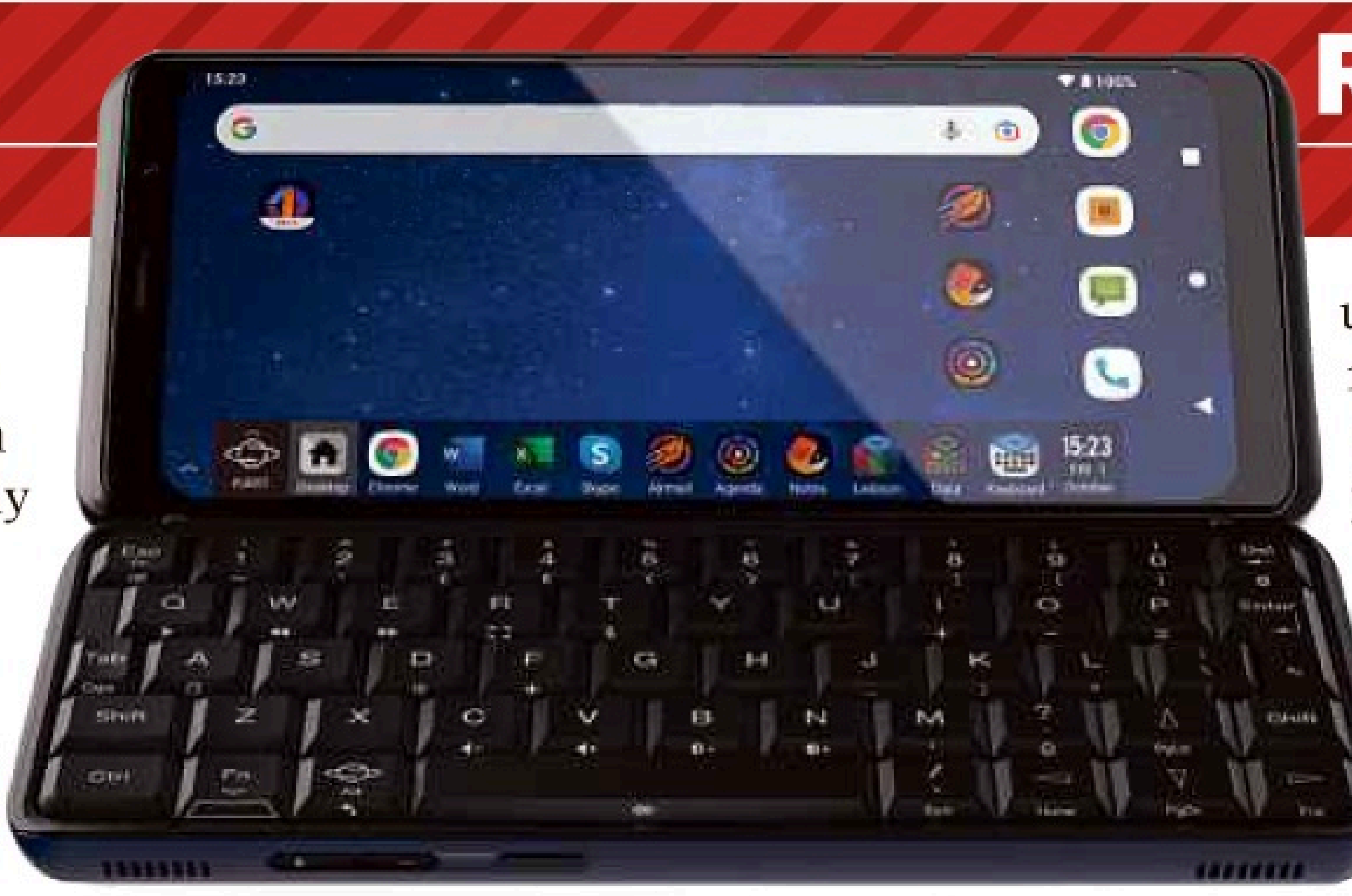
One final nice feature is the smart button on the left-hand side. Head into the dedicated Astro Settings section of Android's Settings menu and you can program it in one of three ways: a short press, long press or double-press. For example, I set a short press to start the torch and a long press to launch BBC Sounds.

One in the hand

At this point we must tackle the big problem for the Astro Slide compared to a normal phone: its bulk. It's twice as thick and heavy as a typical phone, and that makes it far more noticeable in a trouser pocket. You might also feel self-conscious making phone calls with such a lump against your ear. It would be great for a future edition to lose a couple of millimetres from the base and for the lid to become even slimmer.

This brings me to the screen, which overall is a plus point: AMOLED technology ensures rich colours, while a 1,080 x 2,340 resolution equates to a 403ppi pixel density across the 6.4in diagonal. It's protected by Gorilla Glass (third generation), reached a highly respectable peak brightness of 400cd/m^2 and covers 100% of the DCI-P3 colour space. If anything, it's *too* keen with its colours: they whack you between the eyes with their sheer saturation. Nor is colour accuracy a strength, with an average Delta E of 2.77 well over our ideal of less than 1.

I'm not fond of the panel's corners having such big curves cut into them, but the more notable issue is the amount of space above and below the screen: there's a 12mm bezel at the bottom and 13mm at the top. The only plus point of the latter is that it leaves space for the earphone speaker and the 13MP selfie camera.



ABOVE The width of the device is the only limiting factor when it comes to typing

Camera obscura

I must play down your expectations when it comes to the cameras. The front one isn't far off what you'd see from a mid-range phone, but firing up the Camera app reveals a lack of finesse and options – think self-timer, image size and that's it. Its results aren't awful by any means, but an iPhone this is not.

It's a similar story for the rear camera, despite the comforting presence of a 48MP Sony sensor. This means you can push all the way up to 8,000 x 6,000 resolutions, but usually the benefit of such a huge sensor is for pixel binning to reduce noise in low light. Nothing so clever is happening here, and the end results were mushy and lacked detail compared to a half-decent modern phone.

You can take videos using both cameras, but there's no optical image stabilisation and again you aren't given many options. There are scene modes – sports, snow and night, for instance – but I could see little difference in the end results.

Rescue remedy

A lag when shooting video was one of the few times that I wished for a higher-spec chipset, because otherwise the MediaTek Dimensity 800 proved more than a match for Android 11. Videos played smoothly, as did *Minecraft*. More demanding games will prove an obstacle – it scored 10fps in the demanding 3DMark Time Spy test – but this is a solid mid-range chip.

That is echoed by its scores in benchmarks, with a single-core result of 504 in Geekbench 5 and 2,202 in the multicore test. Its result of 16hrs 45mins in our video-rundown test is again solid; you'll need to use this phone intensively to drain the 4,000mAh battery over the course of a day.

It's also good to see support for wireless charging here, up to a maximum of 10W. Switch to the 30W USB charger if you want quicker top-ups, even if a figure of zero to 24% in 30 minutes is hardly stellar.

Ports ahoy

You can charge the Astro Slide via either of its USB-C ports, which are placed on opposite sides. Both support OTG and video output, but not directly via USB-C; instead you'll need to buy a USB-C to HDMI converter, such as the one that Planet sells for £33. Or you can buy its USB-C hub for £37, which adds two USB-A ports and an Ethernet connector. All of which makes sense if you plan to take advantage of this device's support for booting into Linux-based operating systems, with plans for Debian, Kali and the phone-friendly Sailfish OS.

"In many ways, it's a flexible and forward-thinking device, with some ingenious features. In others, it feels basic and hamstrung"

Further versatility comes through the Astro Slide's dual SIMs, with space for two nano SIM cards in its extra-long SIM tray along with a microSD card (128GB of storage comes as standard). Or you can use an eSIM. Both SIMs support 5G, with the only blot on this phone's connectivity being support for Wi-Fi 5 rather than Wi-Fi 6.

ABOVE The rear camera has a 48MP sensor but photos are disappointing

This yin and yang is typical of the Astro Slide 5G. In many ways, it's a flexible and forward-thinking device, with some ingenious features that could save you time and hassle. In others, it feels basic and hamstrung (think the camera and accompanying app). You must also bear in mind that you're buying from a small company rather than an international giant, which comes with drawbacks along with its advantages.

Overall, however, the Astro Slide's positives outweigh the negatives, and let's never forget that this is a unique device. If you have a compelling reason for a physical keyboard, it's the best solution I've tested by some distance. **TIM DANTON**

LEFT The Astro Slide remains steady even when you're bashing away on the keyboard

SPECIFICATIONS

8-core 2.6GHz/2GHz MediaTek Dimensity 800 ● 8GB RAM ● Mali-G57 MC4 graphics ● 6.4in 60Hz AMOLED screen, 1,080 x 2,340 resolution ● 128GB storage ● microSD card slot ● 48MP rear camera ● 13MP front camera ● backlit mechanical keyboard ● Wi-Fi 5 ● Bluetooth 5.1 ● NFC ● 2 x USB-C ● 3.5mm jack ● 4,000mAh battery ● Android 11 ● 76 x 18.8 x 171mm (WDH) ● 320g ● 1yr RTB warranty

PCSpecialist Titan Spark

Superb performance thanks to a 12th gen Core i5 CPU and RTX 3060 Ti graphics – and at a fine price, too

SCORE ★★★★☆

PRICE £1,125 (£1,350 inc VAT)
from pcspecialist.co.uk/reviews

The Titan Spark is a handy reality check this month. Amid all the great innovation on show at CES (*see p26*) and stunning laptop designs such as the Asus ProArt Studiobook OLED 16 (*see p56*), the dependable desktop PC continues to deliver in three key areas: speed, value and simple upgradability.

It's only right to start with speed, as the Titan Spark flies. The Core i5-12600KF is proof once more that Intel has delivered with the 12th generation Alder Lake family. It raced through the *PC Pro* benchmarks with a score of 457, then punched its way to a 8,023 tally in PCMark 10. Cinebench R23 proved no challenge, with a 16,957 result in the multicore test. Compare that triumvirate of scores to the Asus – ludicrously fast for a laptop, lest we forget – and its results of 354, 6,892 and 12,638.

You can also overclock the i5-12600KF if you wish (the "K" in its name indicates that it's unlocked). PCSpecialist supplies one of its gigantic air coolers to give you every chance of succeeding, and the Asus TUF Gaming Z690-Plus WiFi D4 motherboard is a fine partner in crime. Alder Lake allows you to overclock the six Performance and four E cores separately, bringing yet more flexibility into play.

This choice of motherboard commits you to DDR4 memory rather than DDR5. As we covered in our in-depth review of Alder Lake two months ago (*see issue 328, p48*), the reduced bandwidth doesn't notably affect results in games or in general use, but we did see a jump in the synthetic 3DMark Time Spy test. Could this mean that future games come along that take advantage of DDR5 and make DDR4 look like a bad choice? Frankly, I doubt it. With DDR4 still far cheaper than DDR5, and more readily available, it's only worth investing in if you want to remove all possible bottlenecks. The bigger limitation here is that the air cooler overhangs one of the DIMM sockets, so if you want more than 16GB you'll need to change your cooler at the same time.

PCSpecialist chooses a high-quality memory kit in the Corsair Vengeance RGB Pro, and as their name gives away these will also add extra colour to the inside of the case. The chassis, a solid mid-range affair, includes a tempered glass side, while three RGB fans shine through the grille at the front. You can fine-tune the colours on the motherboard and DIMMs using Corsair's iCue software, but you'll need the supplied remote control to change the colours of the front fans.

These basic units don't use pulse-width modulation (PWM) so always emit the same audible hum (not an irritating hum, thankfully), whether the PC is sipping its idle power of 66W or hitting its 369W maximum. Consider spending £75 on a Corsair LL120 RGB fan kit at some point, as this provides dual benefits of PWM and control via iCue.

Mind you, your first purchase might be to supplement the 1TB Intel 670p M.2 SSD, and with three M.2 slots lying empty on the motherboard you have plenty of options. Or you may prefer to add a 3.5in hard disk in the sole available bay once you remove the chassis' right-hand panel, with one empty 2.5in caddy nearby too.

More expansion comes courtesy of three PCI-E slots on the motherboard, but there's no immediate need to take advantage. Networking is amply covered by the 2.5GbE port and built-in Wi-Fi 6, while there's a generous number of USB ports. These include two USB-C connectors, and they proved suitably quick in my tests: an 11GB transfer from an external SSD typically takes a minute on laptops, but here that finished in 23 seconds.

Then we come to this machine's other star component: a GeForce RTX 3060 Ti graphics card. Combined with the Core i5-12600KF, this makes the Titan Spark a fantastic choice for 1440p gaming: at High quality settings, it returned 83fps in *Metro Exodus* and 139fps in *Shadow of the Tomb Raider* (with DLSS set at Quality). *Hitman 2* averaged 42fps with 2x super sampling, but dropping this to 1x saw 135fps frame rates.

So, I have zero complaints about speed. Likewise value, which is terrific; I tried to configure a similar spec elsewhere and it came in at over £1,500. And, aside from the RAM, the Titan Spark's upgradability is top-notch. As this is a fixed-spec system, though, you can't use PCSpecialist's online configuration tool to adjust it – and you can expect to wait around two weeks for the system to arrive. The wait and lack of configuration are minor setbacks, however: I have no hesitation in recommending the Titan Spark. **TIM DANTON**

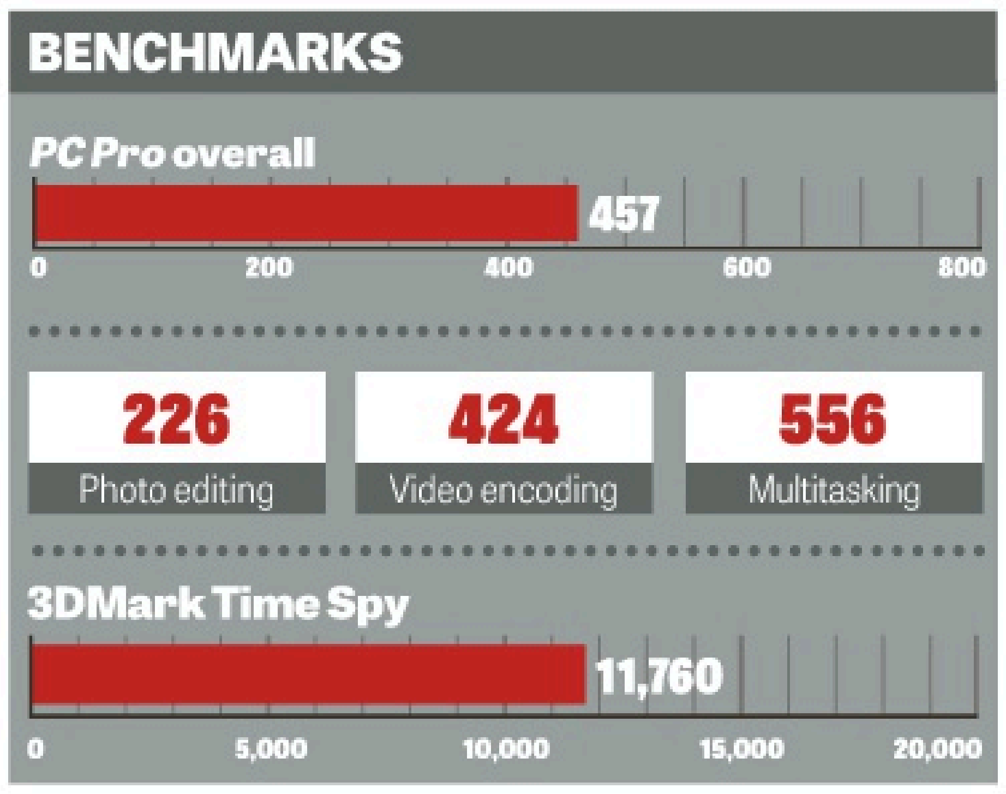
ABOVE **With all the colours blazing, this PC makes its presence felt on a desk**

PC PRO RECOMMENDED

> **"Combined with the CPU, the GeForce RTX 3060 Ti graphics card makes the Titan Spark a fantastic choice for 1440p gaming"**

LEFT **A giant air cooler dominates inside, but the RTX 3060 Ti is the star**

BENCHMARKS

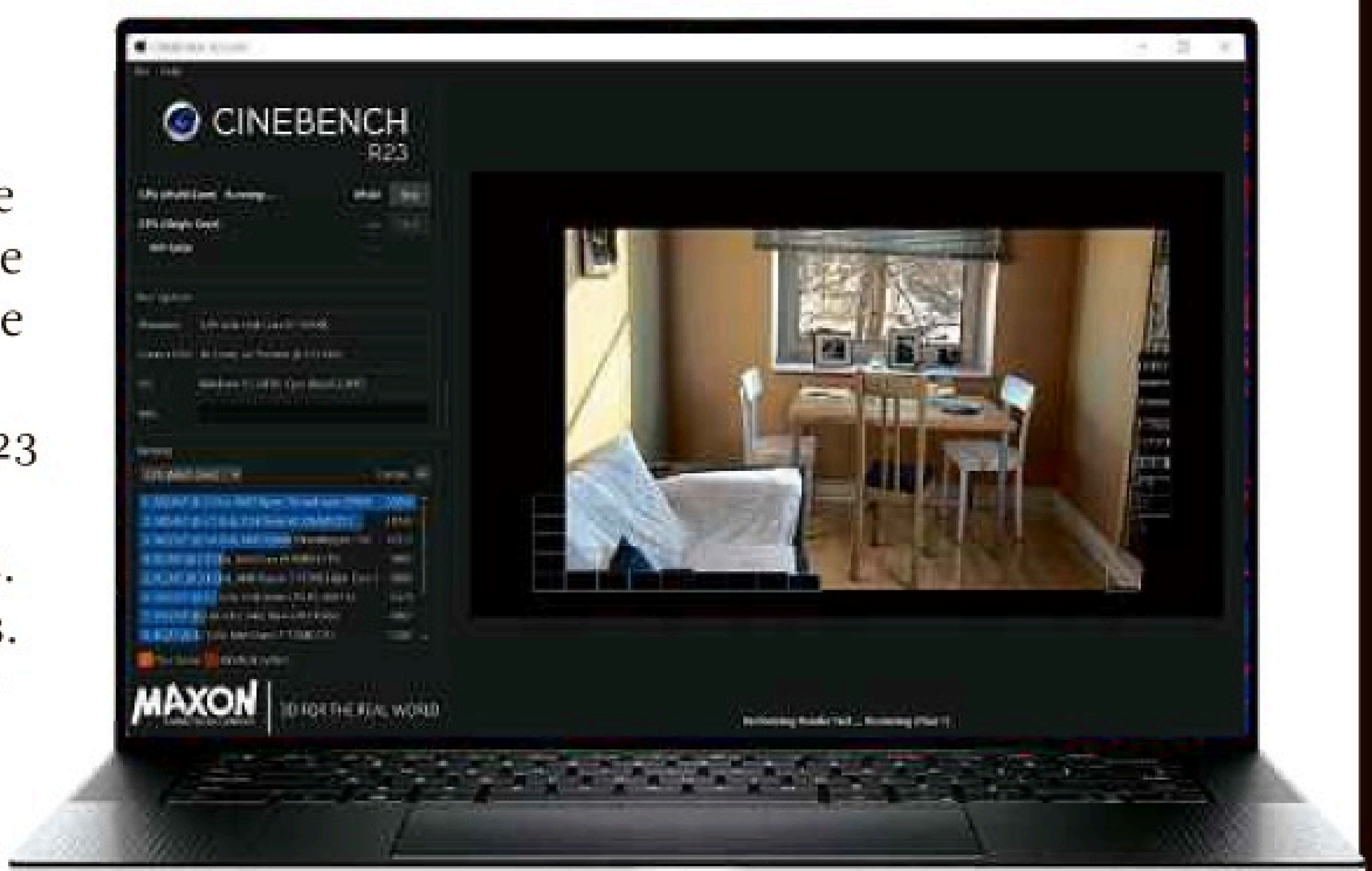


SPECIFICATIONS

10-core 3.7GHz (4.6GHz burst) Intel Core i5-12600KF processor ● Asus TUF Gaming Z690-Plus WiFi D4 motherboard ● 16GB Corsair Vengeance RGB Pro 3,600MHz DDR4 RAM ● 8GB Nvidia GeForce RTX 3060 Ti graphics ● PCS air cooler ● 1TB Intel 670p M.2 PCI-E 3 SSD ● PCS Spectrum RGB mid-tower chassis ● 650W Corsair TX650M PSU ● Windows 11 Home ● 210 x 412 x 458mm (WDH) ● 3yr warranty (1 month C&R, 1yr RTB parts & labour, 2yr labour only)

How we test

Laptops and PCs



We run a selection of benchmarks on all the PCs and laptops we test. Where possible, we use a cross-platform test so we can compare Windows and macOS machines, which is where both Geekbench 5 and Cinebench R23 come into play. Both push the CPU to its limit, exposing how well cooled a system is.

We run extra tests for Windows systems. We use our own benchmarks to test photo-editing, video-encoding and multitasking speeds. We then switch to PCMark 10 to benchmark systems in office tasks, content creation and basic tasks such as web browsing and video calls. We also run 3DMark Time Spy and a selection of benchmarks in games such as *Metro Exodus* and *Shadow of the Tomb Raider*.

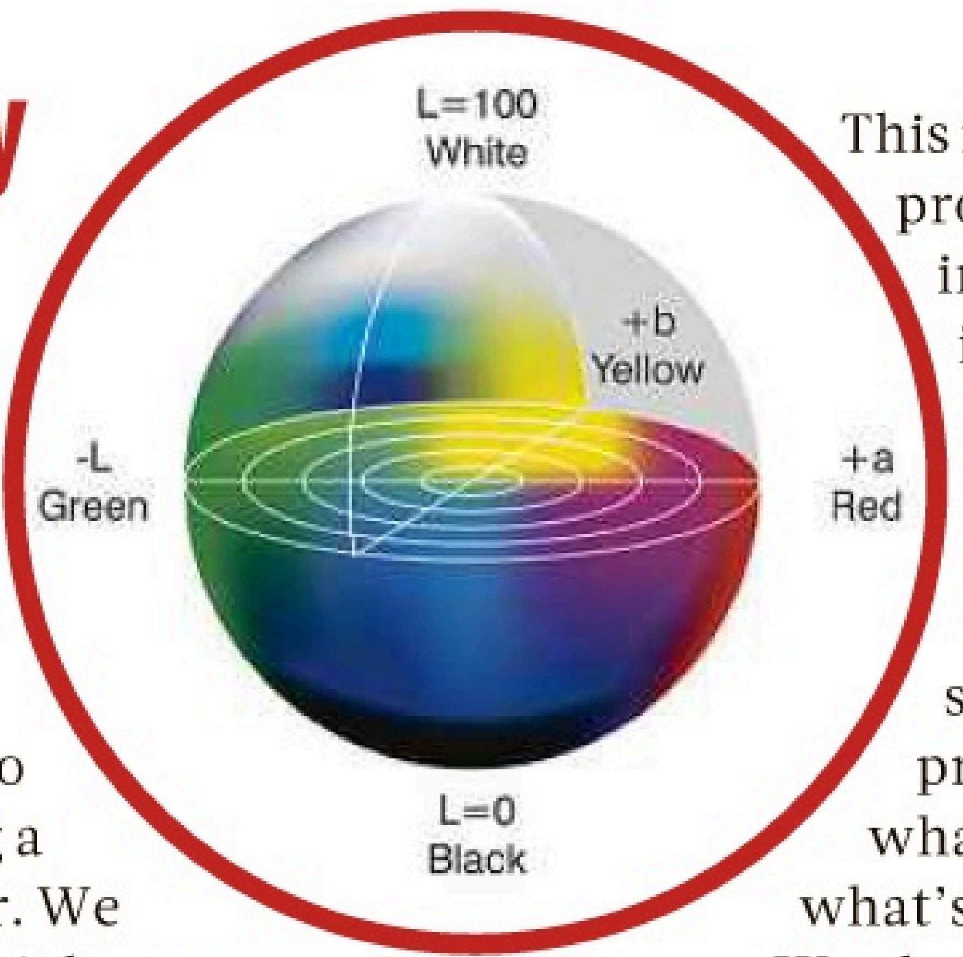
For laptops, we test battery life with Wi-Fi on and the screen brightness set to 170cd/m². We fully charge the laptops and drain them until they reach 5% using two tests. First, PCMark 10's battery life benchmark: this mimics light use with tasks such as word processing, video chat and web browsing (plus idle periods). Second, a video-rundown benchmark that loops a 1080p video in VLC Player.

ABOVE We put PCs and laptops through our intensive set of benchmarks

LEFT We use a Display i1 colorimeter to measure sRGB gamut coverage and Delta E

BELOW We play a video with the screen set to 170cd/m² to test battery life

Screen quality



In each laptop, phone, tablet and monitor review, you'll see our conclusions about the screen quality. Some of this will be subjective, but we also test each screen using a Display i1 colorimeter. We measure maximum brightness, colour accuracy and consistency – there may be a difference in, say, brightness from the middle and the edges of the panel.

i1 DISPLAY
x-rite

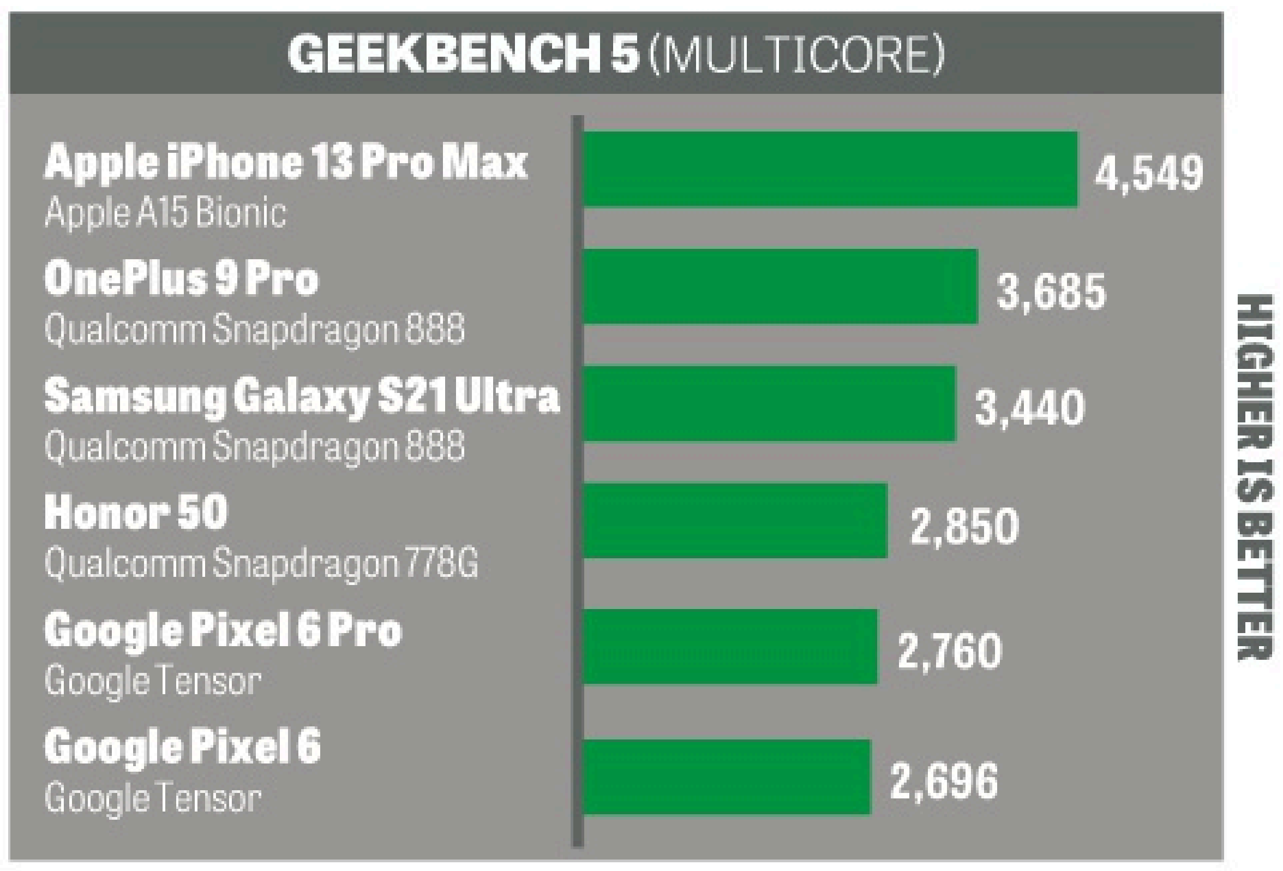
We also measure Delta E, which gives a guide as to how accurately the panel displays a colour. Anything under 1 is excellent and likely to be difficult for the human eye to distinguish; between one and two is still strong; above this suggests a panel that you shouldn't trust for colour-accurate photo editing.

Phones and tablets

We run a selection of publicly available benchmarks on all the phones and tablets we review. First, we run Geekbench 5 (**geekbench.com**). This is a good test of the processor and memory in particular, and includes both a test for single-core and multicore performance. See below for a selection of scores to provide a reference of what's good... and what's not so good.

We also run the graphics-intensive GFXBench (**gfxbench.com**) to see how well the phones and tablets are likely to perform in games.

As with laptops, we test phone and tablet battery life by playing a full-screen video until the battery runs out with the device in Flight mode. We set the brightness to as close to 170cd/m² as we can get in its settings.



What our awards mean

Recommended

This, quite simply, is a product we recommend you buy – if it meets your needs.

A-List

The best buy in its category right now. The product will also feature on our A-List, starting on p14. It's updated each month.

Labs Winner

Each month we run a group test, or Labs. This product has managed to beat all others to top position.

The pcpro.link

Throughout the magazine you'll see pcpro.link shortcuts. Enter these into the address bar of your browser and it will take you to a particular page, which will either be too long or awkward for us to publish or will take you to the precise shop from which to buy. If it's Amazon, note that we have an affiliate deal in place so we will receive a commission from each sale. This will never affect our verdict of a product, and if another reputable vendor is selling the product cheaper then we will use that instead.

Prices will vary

Prices we publish are correct on the day we publish, but we often see prices change, especially on sites such as Amazon. However, we do work with British PC retailers to ensure the prices we quote for their systems are correct. If the price isn't being honoured, contact us via letters@pcpro.co.uk.

SCAN IT

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Scan recommends Windows 11

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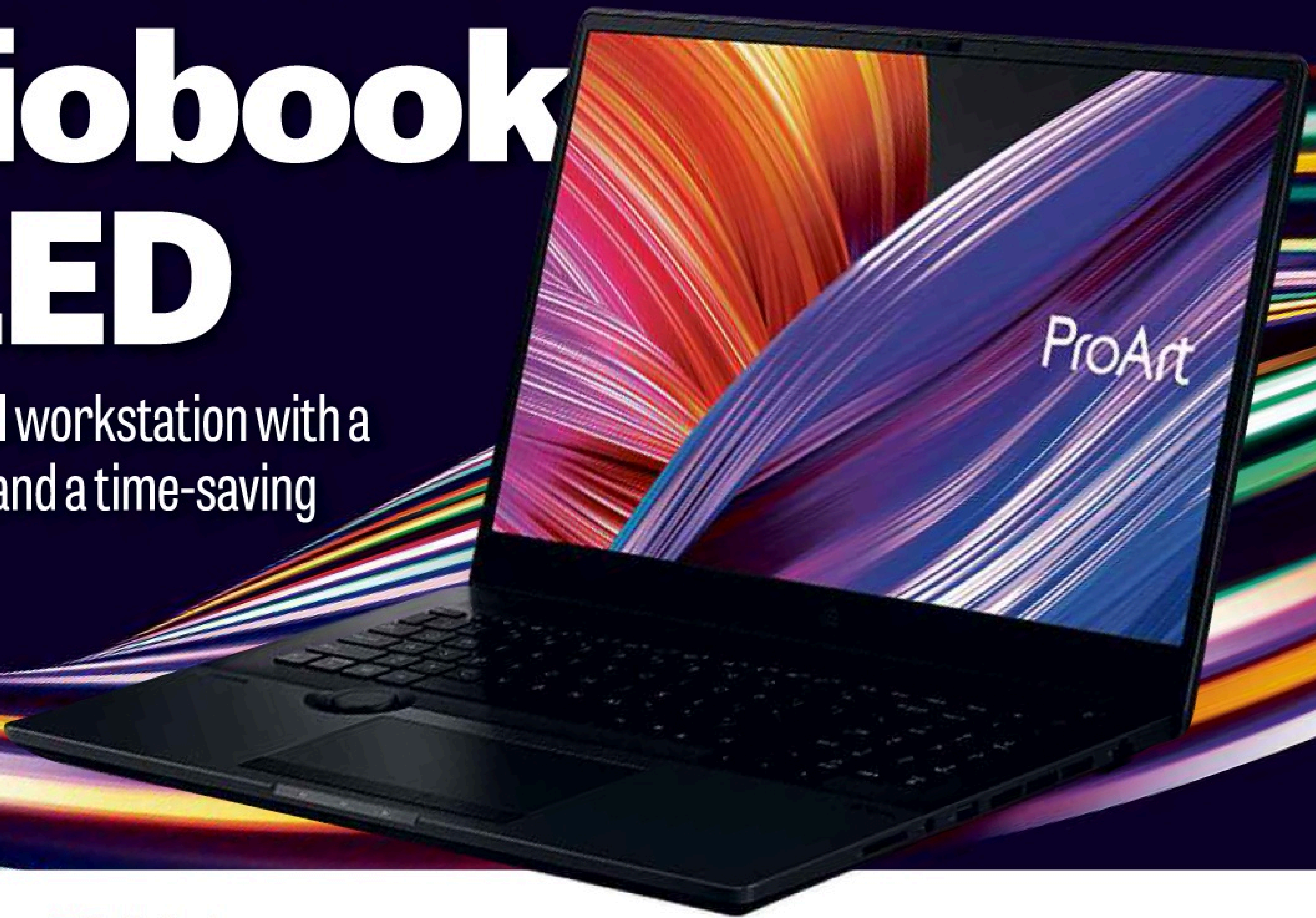
Virtual Rendering Service (vRS)

Provides access to rapid GPU rendering without the need to invest in your own servers and infrastructure.

Asus ProArt Studiobook 16 OLED

A staggeringly powerful workstation with a gorgeous OLED screen and a time-saving integrated dial



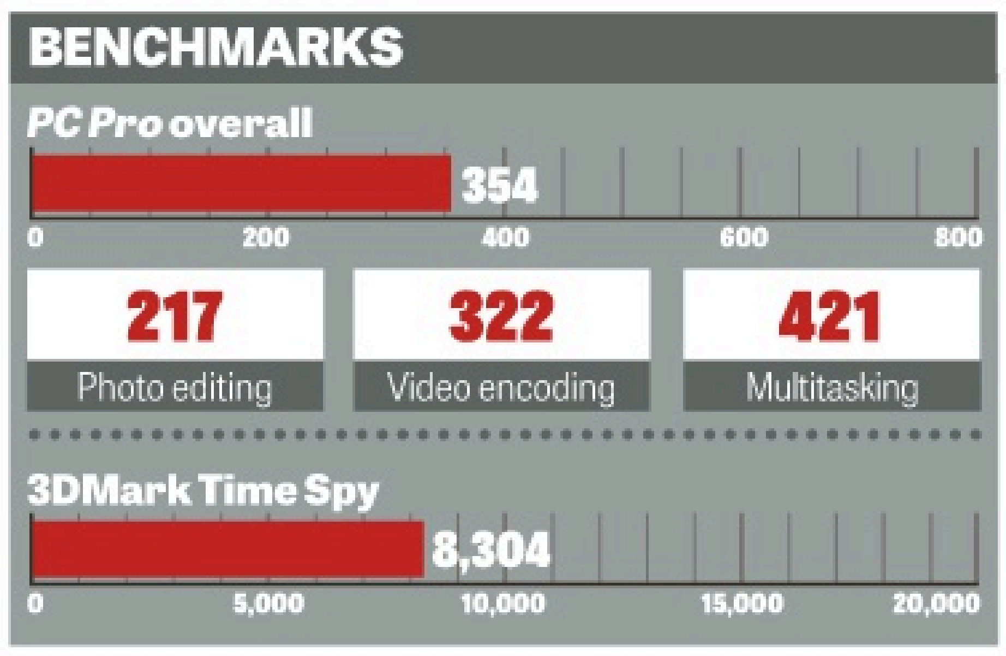
ABOVE The ProArt Studiobook packs in the power despite its slim dimensions

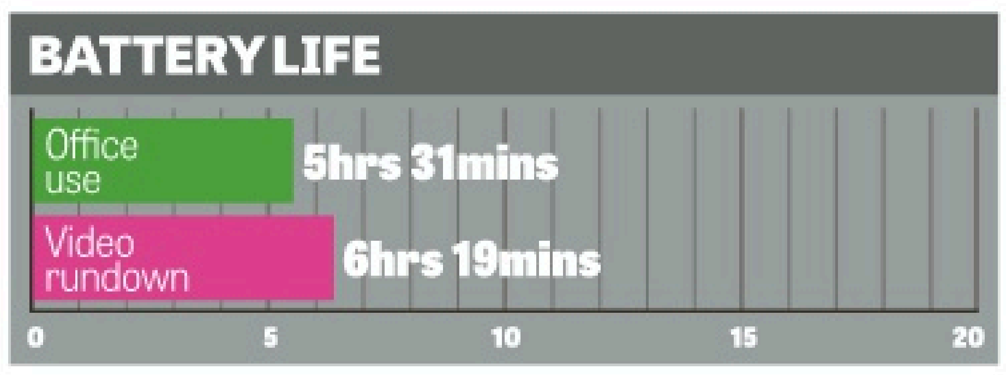
SCORE ★★★★☆

PRICE £2,083 (£2,500 inc VAT) from scan.co.uk

Allow me to dangle temptation into your path: a mobile workstation not only packed with so much creative power it would make George Lucas weep, but one that integrates a time-saving dial that's perfect for scrubbing through timelines and fine-tuning settings.

Still on the fence? How about a glorious 16in AMOLED screen, 2TB of RAID storage and one of the finest keyboards I've ever used? The ProArt Studiobook isn't perfect – read on to discover its quirks – but if you sit unmoved, then your creative heart has surely turned to stone.





Full circle

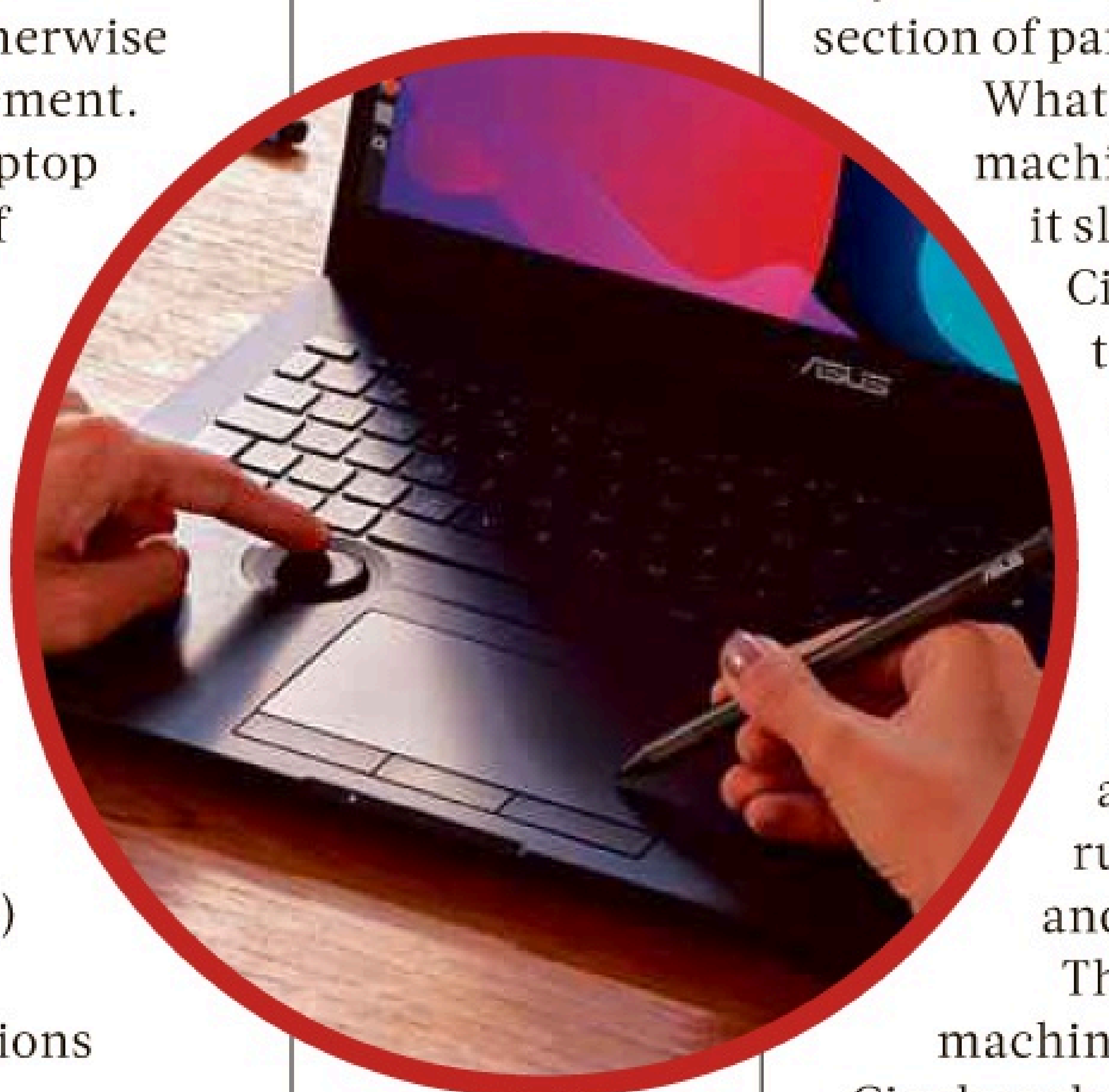
I'll start with the most intriguing inclusion, the Asus Dial. If you're in Windows, pressing it reveals a choice of two segments (think Trivial Pursuit): volume and brightness. Highlight a segment, press down and then you have fine control over the level, so you can scroll instantly from 0 to 100. A two-year-old can master this.

I love that the controls skip so easily between granular (say, from 80% brightness to 81%) and sweeping, so it takes a moment to move from 0% to 100%. That's merely convenient for brightness, but could be a colossal time-saver in tasks that otherwise involve fiddly mouse movement.

Asus is launching the laptop with support for a bunch of Adobe apps, including Photoshop, Premiere and After Effects. I tried it out in Photoshop, where it allows you to cycle through open images, zoom in and out, access brush effects (this brings up a submenu of brush options, so you can choose brush opacity, for example) and quickly undo recent changes. I expect more options will come in the future.

Note that the dial sits under your left hand, which worked fine for me as a right-handed person but could be an issue for left-handers. Thankfully, it didn't get in the way when I was typing. Unlike my Surface Dial, which sits in a drawer, I could see myself using the Asus Dial every day.

PC PRO RECOMMENDED



ABOVE The Asus Dial is a brilliant way of making fine and not so fine adjustments

Zippy speed

It helps that the ProArt Studiobook is so quick. Top pegging goes to the AMD Ryzen 9 5900HX processor with its eight cores and 16 threads. With the help of 32GB of RAM and a 2TB RAID array we'll come to shortly, this romped to 354 in the *PC Pro* benchmarks. A score of 6,892 in PCMark 10 is similarly admirable, with its 9,953 tally in the Digital Content Creation section of particular note.

What hammered home this machine's power was the way it sliced through the Cinebench R23 multicore test with such speed it almost made a mockery of the test, scoring 12,638 overall. That's faster than an Apple MacBook Pro 16in with an M1 Max processor; I asked Jon Honeyball to run the test on his beast, and it scored 12,367.

That's with both machines plugged in. I ran Cinebench R23 multicore, a ten-minute benchmark, twice on the battery and it scored 11,365 and 11,414 with the battery falling by 27%. When Jon did the same, his MacBook scored

12,361 and 12,364, while its battery fell by a mere 10%. In other words, the MacBook Pro is just as fast on battery whilst consuming less power. It's also fanless, while you hear the low buzz of the ProArt's fans when pushed.

Battery of blows

When you consider the 16in OLED screen and powerful components, much is being asked of this laptop's 90Wh battery. As such, it isn't a shock that it lasted, at best, six hours in our light-use tests. You will need to carry the chunky 240W power supply with you on day trips.

That will add 730g to your bag's load, but kudos to Asus for keeping the Studiobook's dimensions and weight down. It's a surprisingly slender 21.4mm and weighs 2.4kg, and while a width of 362mm means you'll need a good-sized rucksack, it falls on the right side of portable.

The Studiobook has a sturdy metal exterior to protect it from bashes in the field, with Asus boasting it exceeds the MIL-STD-810H tests. There's also an industrial chic to its matte black finish, helped by an effective anti-fingerprint coating.

There's no Thunderbolt 4 support, which means the two USB-C ports on the left support USB 3.2 Gen 2's 10Gbits/sec rather than 40Gbits/sec. But that's my only bandwidth criticism: the HDMI output supports 2.1, so 8K screens at 120Hz are in play; there are two USB-A ports (both 10Gbits/sec); and Asus finds room for a Gigabit Ethernet connector, too.

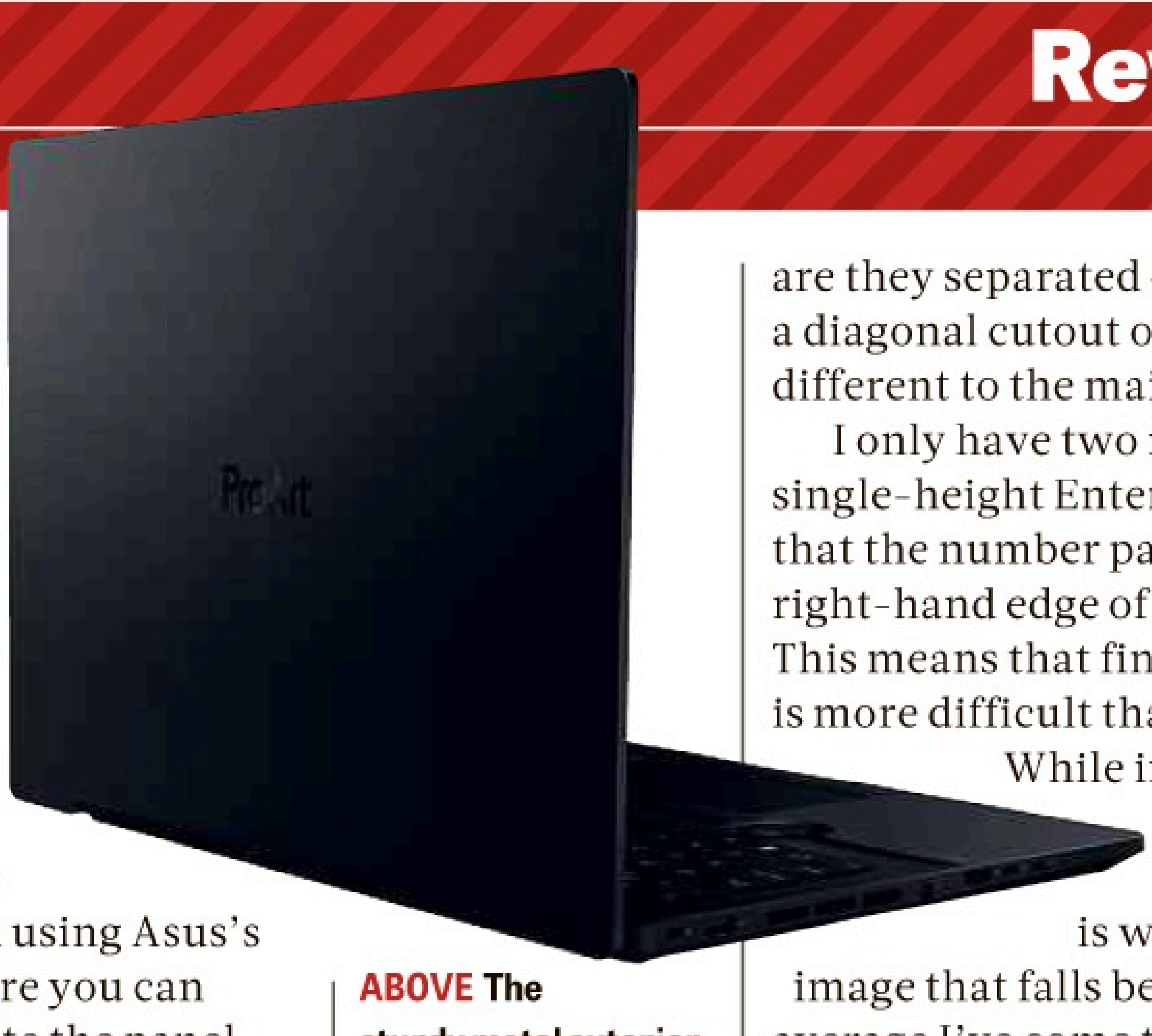
The big bonus, though, is the SD Express 7 card reader. This is a blisteringly quick way to transfer photos and videos from a camera.

Creative solutions

Then we come to the graphics card, a GeForce RTX 3070 (the 90W version with 110W boost). Using Nvidia Studio drivers, this is certified for creative software such as Adobe CC titles, 3ds Max, DaVinci Resolve and SketchUp.

The RTX 3070 is a great choice for games too: the Studiobook scored 8,304 in 3DMark Time Spy, 78fps in *Metro Exodus* and 110fps in *Shadow of the Tomb Raider*. The latter two were at 1080p and High settings, but switching to the screen's 3,840 x 2,400 resolution saw those results drop to 31fps and 43fps. Activating DLSS in Performance mode pushed *Shadow of the Tomb Raider* to 65fps.

The screen isn't designed for games, with a 60Hz refresh rate, but every time I glanced over during games testing I was struck by the richness of the scenes. They truly look fantastic, as do dark, moody films such as *Blade Runner: 2049*. It helps to have passed VESA's HDR True Black 500 certification, but other AMOLED screens will go higher than the 399cd/m^2 I measured. Asus claims 550cd/m^2, but that will be in localised areas during HDR content playback.



ABOVE The sturdy metal exterior exceeds MIL-STD-810H standards

The screen has been Pantone validated, and using Asus's ProArt Creative software you can even hardware-calibrate the panel. Not that it made much difference in my tests. Before and after, it covered 99% of the DCI-P3 colour space and 96% of Adobe RGB. With an average Delta E of 0.37, and maximum of 0.76, this is a tough screen to criticise. In fact, I would only draw your attention to two practical elements: the glossy finish and the lack of touch support.

Practical elements

If you're a fan of Windows' gesture control, you'll be pleased by the wide, glass-coated touchpad beneath the keyboard. It even supports styluses, and while no substitute for a graphics tablet (it's a shame the touchpad isn't even bigger), it works well. Asus also includes old-fashioned physical buttons, with a scroll lock button in the middle as a bonus.

ABOVE The top-quality keyboard has three brightness levels

There's plenty of attention to detail when it comes to the keyboard, too. I'm a fan of the firm backplate, and I suspect that touch-typists will enjoy bashing out words. The backlight has three brightness levels and shines through the key lettering, rather than around the sides, which is both more stylish and less annoying in dark environments. The cursor keys deserve special mention. Not only are they separated out, but Asus adds a diagonal cutout on them so they *feel* different to the main keys.

I only have two niggles. One is the single-height Enter key, the other that the number pad is so close to the right-hand edge of the "main" keys. This means that finding the Enter key is more difficult than it should be.

While in critical mood, let's talk webcams. The 720p unit here is woeful, with a fuzzy image that falls below even the poor average I've come to expect from Windows laptops. Audio capture is much better – and the Studiobook's Harman Kardon speakers are excellent, loud affairs – but only use this laptop for video calls as a last resort.

Final cut

As I said at the top of this review, the ProArt Studiobook 16 OLED isn't perfect. And it falls behind the most recent MacBook Pros in terms of both battery life and performance on the move. However, Asus has one big advantage: price.

> **"It falls behind recent MacBook Pros in battery life and performance on the move. However, Asus has one big advantage: price"**

Scan will sell this laptop for £2,500 (use its product code LN119713), and you'll pay £3,399 for a similarly specified M1 Pro MacBook Pro. The M1 Max version costs another £200 on top. That price includes 2TB of storage to match the Asus, and both machines are equally fast here: the Studiobook's RAID setup of two 1TB SSDs returned sequential read speeds of 4,547MB/sec and writes of 5,940MB/sec. It will also be easier to upgrade the Asus than the MacBook, with ten crosshead screws standing between you, two M.2 SSD slots and its pair of SODIMM sockets.

Lacklustre battery life robs the ProArt of a star in our ratings, but this is a fantastic mobile workstation. With all the power and quality on offer, and the time-saving appeal of the built-in Asus Dial, the ProArt Studiobook 16 OLED is a brilliant choice for creatives. **TIM DANTON**

SPECIFICATIONS

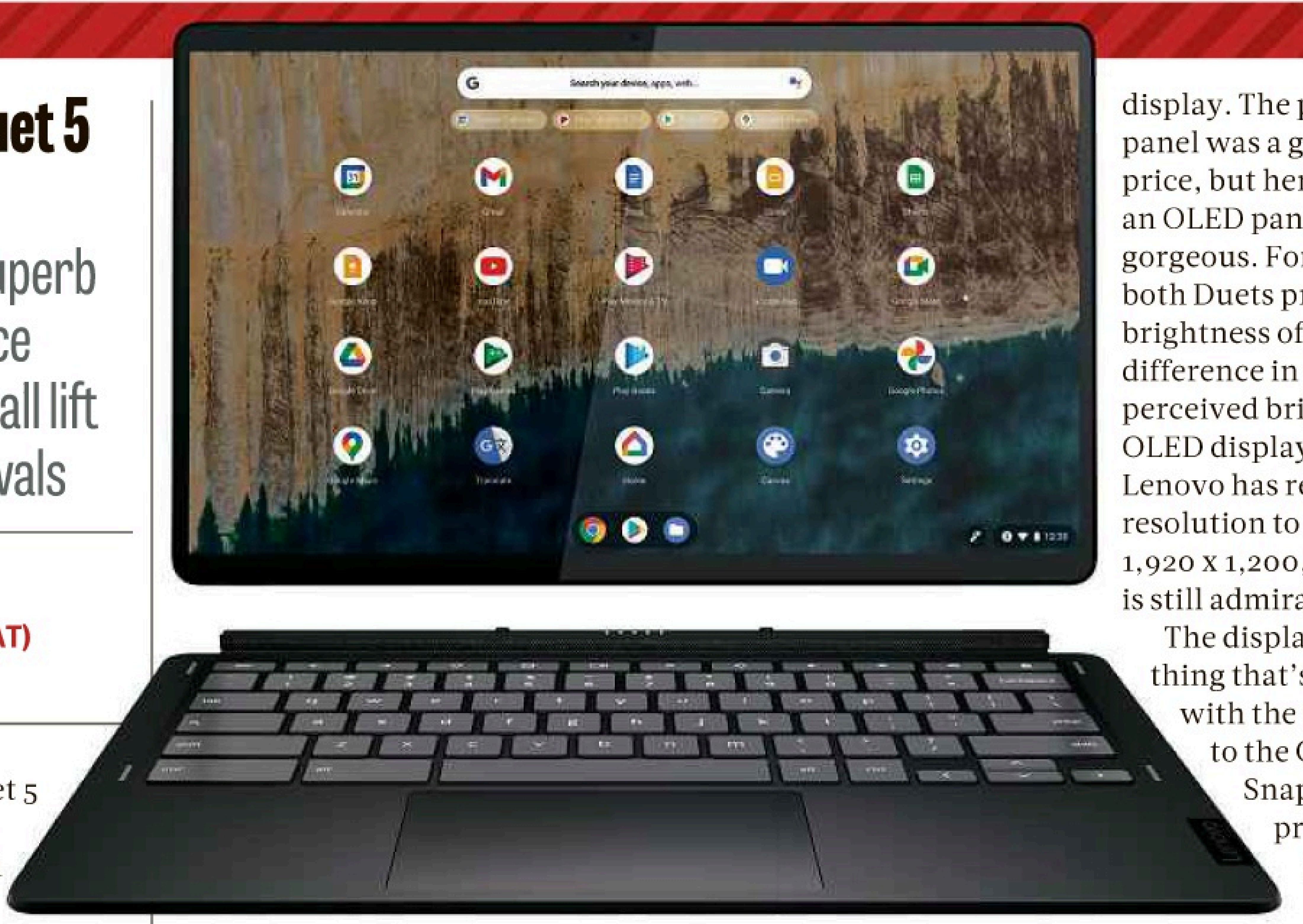
8-core 3.3GHz (4.6GHz burst) AMD Ryzen 9 5900HX processor ● 32GB DDR4-3200 RAM ● 8GB Nvidia GeForce RTX 3070 graphics ● 16in 60Hz AMOLED non-touch panel, 3,840 x 2,400 resolution ● 2 x 1TB M.2 PCI-E SSDs ● 720p IR webcam ● Wi-Fi 6 ● Bluetooth 5.2 ● HDMI ● 2 x USB-C 3.2 Gen 2 ● 2 x USB-A 3.2 Gen 2 ● Gigabit Ethernet ● SD card reader ● 3.5mm jack ● 90Wh battery ● Windows 10 Pro ● 362 x 264 x 21.4mm (WDH) ● 2.4kg ● 1yr limited warranty ● part code H5600QR

Lenovo IdeaPad Duet 5 Chromebook

A gorgeous display, superb battery life and Surface Pro-style form factor all lift the Duet 5 above its rivals

SCORE ★★★★☆

PRICE 256GB, £458 (£550 inc VAT) **from lenovo.com/uk**



ABOVE At 13.3in, the detachable keyboard is similar to those on ultraportables

The Lenovo IdeaPad Duet 5 Chromebook is finally here, a device I've been excited to try ever since it was announced in September 2021. That's because the IdeaPad Duet (*see issue 321, p86*) was arguably the stand-out laptop in our most recent Chromebooks group test, and the Duet 5 Chromebook improves on last year's offering in several important ways.

Let's start with the obvious change: it's bigger. The original Duet Chromebook featured a 10.1in display, which inevitably meant that its detachable keyboard also measured around 10in diagonally. This rules it out for people who don't have much dexterity in their hands or don't want to type with hunched-up claws.

With a 13.3in screen to press up against, the Duet 5 Chromebook's keyboard is much more like those found on ultraportables. The flipside? At this size, and with a 16:9 screen ratio, the Duet 5 is unwieldy as a tablet. That's in part due to its 700g weight (1kg with the keyboard), which is 250g more than the Duet. Both are equally slim, measuring just over 7mm thick, but this means that things have flipped: the Duet was better as a tablet, the Duet 5 is better as a laptop.

As ever with this form of design, you shouldn't expect a perfect on-the-knees typing experience. It's far better on a flat surface, where you don't notice the flimsiness of the design. Nor does it compare well to laptops for the feel of the keys, with a flat action that lacks travel. Finally, note that the keys on the Duet 5 Chromebook keyboard aren't backlit. It's size alone that gives this keyboard appeal.

The trackpad could also be better. My fingers encountered enough friction to give me uneven swiping and gesturing; I got used to it, and learned to adjust the amount of pressure I was applying, but there shouldn't be any need to go through such a learning curve.

Another criticism laid at the door of last year's Duet Chromebook – that the magnetic kickstand could be a pain to extend at times – still remains. A pullable tab or lanyard could easily fix this deficiency, or you can pick up Microsoft's Surface Adaptive Kit as this will work with any device, not just the Surface Pro 8.

The magnetised backplate on the Duet 5 includes a small cutaway for a Lenovo Active Pen stylus to clip to the back, but note that the stylus doesn't come with the £500 model, which includes 4GB of RAM and 128GB of eMMC storage. However, it is bundled with the £550 version, and that has 8GB of RAM and 256GB of eMMC storage. At those prices, there is little reason to choose the cheaper option.

When last year's Duet cost £300, however, you may wonder where all your money is going – and the obvious answer is the display. The previous 10.1in IPS panel was a great choice for the price, but here you're buying an OLED panel. And it's gorgeous. For example, while both Duets promise a peak brightness of 400cd/m^2, the difference in punch and perceived brightness with this OLED display is incredible. Lenovo has reduced the resolution to 1,920 x 1,080 from 1,920 x 1,200, but the end result is still admirably sharp.

> "The previous 10.1in IPS panel was a great choice for the price, but here you're buying an OLED panel. And it's gorgeous"

The display isn't the only thing that's been upgraded, with the Duet 5 stepping up to the Qualcomm Snapdragon 7c Gen2 processor from the MediaTek P60T chip in last year's Duet. Both are high-efficiency ARM-based chips, so neither is going to pack the same kind of raw performance as an Intel Core i3 processor, which some of the beefier Chromebooks feature.

For context, the Duet 5's JetStream 2 score of 83 puts it ahead of the Celeron N4500-powered Samsung Galaxy Chromebook Go (*see issue 329, p57*), but is half the speed of the Asus Chromebook CX9 (*see issue 329, p56*) with its Core i7 chip. It's a similar story in the Octane 2 JavaScript test, where the Lenovo returned 23,798. Mid-table respectability, in other words.

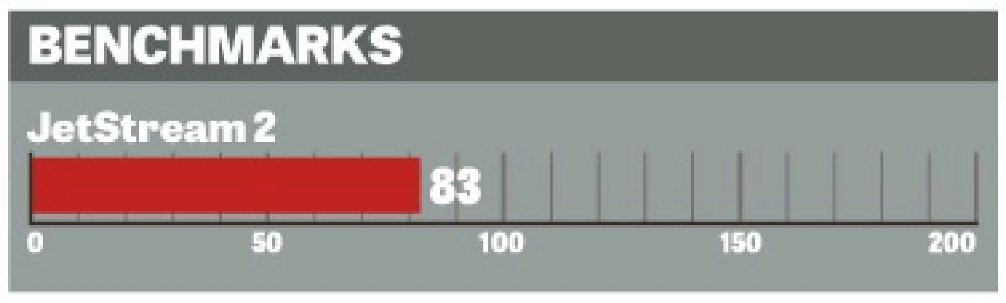
But, crucially, the Duet 5 is twice as fast as the sometimes-sluggish Duet. It finished the Kraken JavaScript benchmark in 1,845ms, compared to the original Duet's time of 3,940ms. And more important than such results is that this Chromebook feels reasonably snappy in daily use.

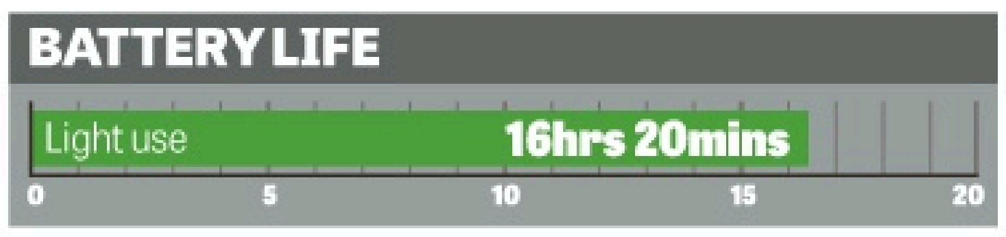
So, while not the most powerful Chromebook, the Lenovo IdeaPad Duet 5 packs enough of a punch to compete with the Chromebook pack. Along with outstanding battery life of 16hrs 20mins in our video-rundown test, a gorgeous display and a new form factor that improves on last year's model, this machine almost lived up to my perhaps optimistic hopes. **JOHN LOEFFLER**

BELOW Lenovo's Active Pen stylus comes with the 256GB version of the Duet 5

SPECIFICATIONS

8-core 2.55GHz Qualcomm Snapdragon 7c Gen 2 ● 4GB/8GB LPDDR4 RAM ● Adreno 618 graphics ● 13.3in touchscreen OLED, 1,920 x 1,080 resolution ● 128GB/256GB eMMC Flash storage ● 2 x USB-C 3.2 Gen 1 ● Pogo pin connector ● Wi-Fi 6 ● Bluetooth 5.1 ● 8MP rear camera ● 5MP front camera ● 42Wh battery ● 306 x 7.2 x 187mm (WDH, tablet only) ● 700g (tablet only), 1kg with keyboard ● Chrome OS ● 1yr warranty





Windows 11

Stormforce™ recommends Windows 11

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2yr/ 10 licences £19.99

Norton is one of the most trusted security brands around, and rightly so: it consistently earns 100% protection ratings from both AV-Comparatives and AV-Test. Norton 360 Premium goes several steps beyond virus protection, however, with a comprehensive selection of tools designed to give you security and peace of mind.

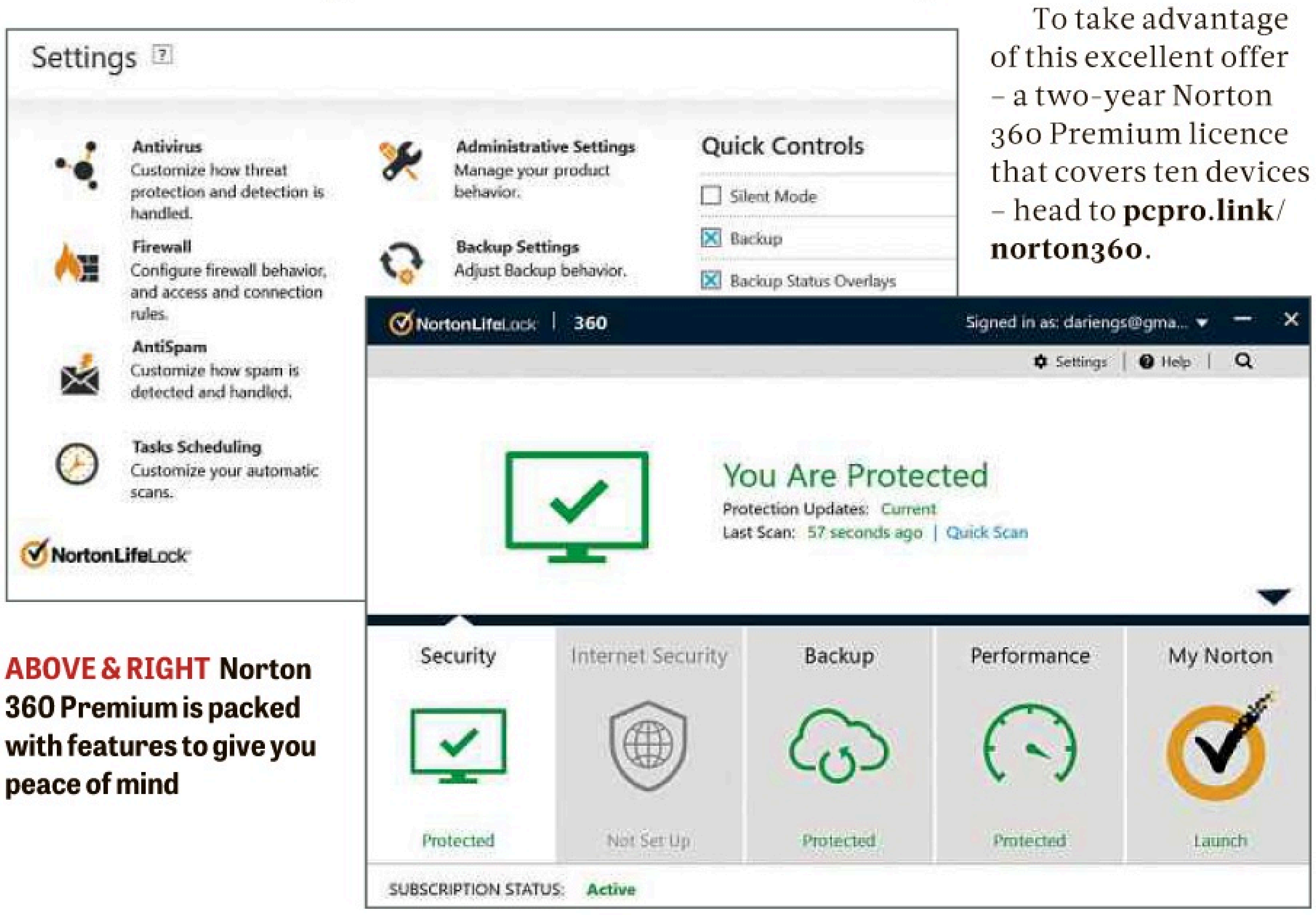
First up is a whopping 75GB of cloud storage space for backups. Whether you already back up to a local disk or not, this provides an easy way to protect your most important files from ransomware or simple data loss.

Then there's the full version of Norton Secure VPN – something that Norton normally charges £40 per year for all on its own. This means that you can browse anonymously wherever you are, block ad trackers and get "bank-grade encryption".

Norton Parental Control provides tools to see exactly what your kids are up to on their various devices: what videos they watch, the websites they visit and the terms they search for. You also get GPS location monitoring for Android and iOS and content filtering for PCs.

Just to round things off, Norton Password Manager generates and stores passwords across all your devices while SafeCam for PC stops cybercriminals attempting to take photos with your webcam without you knowing.

To take advantage of this excellent offer – a two-year Norton 360 Premium licence that covers ten devices – head to **pcpro.link/norton360**.



Settings

Antivirus
Customize how threat protection and detection is handled.

Firewall
Configure firewall behavior, and access and connection rules.

AntiSpam
Customize how spam is detected and handled.

Tasks Scheduling
Customize your automatic scans.

Administrative Settings
Manage your product behavior.

Backup Settings
Adjust Backup behavior.

Quick Controls
☐ Silent Mode
☒ Backup
☒ Backup Status Overlays

Signed in as: dariengs@gma...

You Are Protected
Protection Updates: Current
Last Scan: 57 seconds ago | Quick Scan

SUBSCRIPTION STATUS: Active

NortonLifeLock
NortonLifeLock | 360
Settings
Help
Security
Protected
Internet Security
Not Set Up
Backup
Protected
Performance
Protected
My Norton
Launch

ABOVE & RIGHT Norton 360 Premium is packed with features to give you peace of mind

2 YEAR PRE-PAID SUBSCRIPTION
Norton LifeLock
Electronic Download
10 DEVICES
Norton 360
Premium
Powerful layers of protection for your connected world
Renews Automatically
Continuous Protection each year
100% VIRUS PROTECTION PROMISE
CONVENIENT, UNINTERRUPTED PROTECTION
PRE-BILLING NOTIFICATION

What you get with Norton 360 Premium

Real-time threat protection for up to ten PCs, Macs, smartphones or tablets

PLUS:

- 75GB cloud backup
- Secure VPN
- Parental controls
- Password manager
- Dark Web Monitoring powered by LifeLock
- SafeCam for PC

Buy from the *PC Pro* store at pcpro.link/norton360

Huawei MateView GT 34in

A high-quality curved display with an innovative soundbar; tempting for office workers and gamers alike

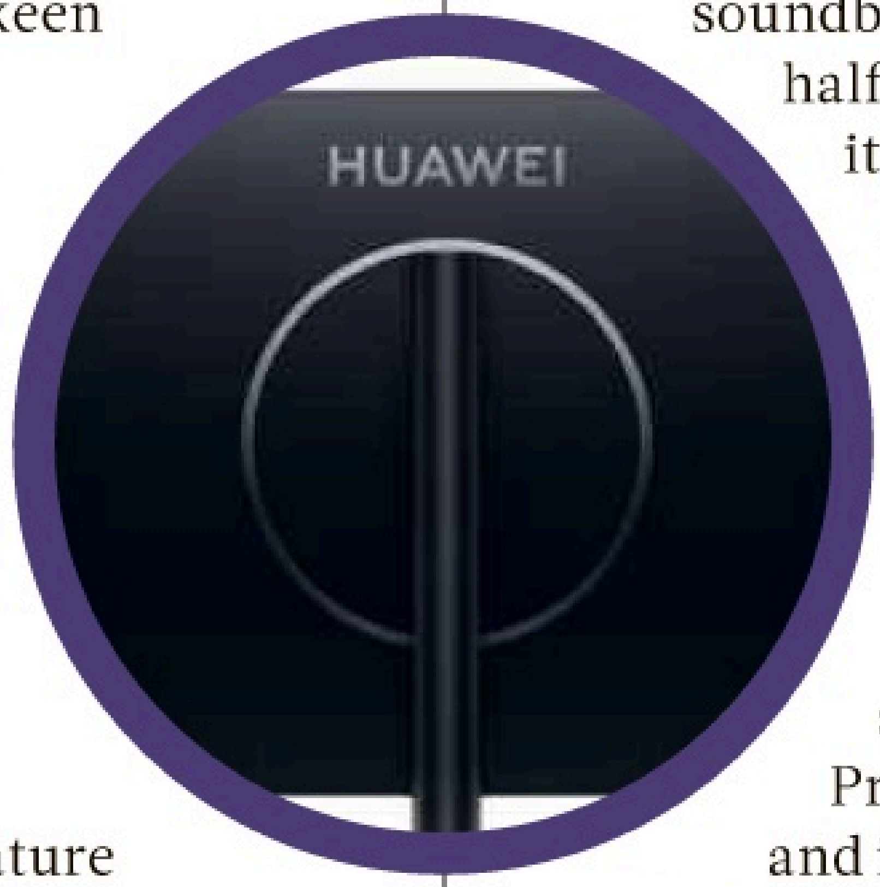
SCORE ★★★★☆

PRICE With sound bar, £416 (£500 inc VAT) from consumer.huawei.com/uk

ABOVE The soundbar is surprisingly powerful considering its compact footprint

As we saw with its first MateView (*see issue 326, p86*), a gorgeous 28.2in monitor with a 3:2 aspect ratio, Huawei isn't afraid to think differently when it comes to screen design. The MateView GT 34in doesn't tear up quite so many rule books as its sibling, but this well-built curved screen includes a handful of nifty features that mean it's equally as happy when the night draws in as it is during office hours.

Some of that versatility is due to a 21:9 panel based on MVA technology. MVA stands for multi-domain vertical alignment, and its historic disadvantage compared to in-plane switching (IPS) panels was that it struggled to display pure whites. A top-quality IPS panel would still win for purity versus the MateView GT, but you would need a keen eye to notice the difference; I was more than happy with this panel's whites when using Google Docs.



LEFT The MateView GT is a stylish screen, with design touches even on the rear

Besides, MVA brings its own collection of plus points. It's better suited to curved screens than IPS, and the gentle 1500R curvature Huawei chooses for this screen feels right for a 34in monitor: it brings the edges closer to your eyes without consuming too much desk space. I'm still recovering from having the 49in Samsung Odyssey Neo G9 (*see issue 327, p91*) on my desk, where it left little space for anything else.

MVA also offers a higher contrast ratio than IPS, with the MateView GT returning a 2,580:1 static ratio result in our tests. That comes in useful when fine-tuning games, making dark corners that much easier to see without blowing out bright areas, and Huawei doubles down by including a "Dark field control" option that tweaks the brightness when it detects dark scenes. There's also a variety of crosshairs to choose from, while a 165Hz refresh rate is surely as high as most people need to go.

The big negative point compared to dedicated gaming screens is its 4ms grey-to-grey response time rather than 1ms. There's no Nvidia G-Sync certification either, but it does support adaptive sync to avoid tearing. One final note: you will need to head into the intuitive, joystick-controlled OSD to activate this panel's topmost Overdrive setting if you want the smoothest results in fast-moving games. Even then, though, high-end 32in gaming monitors such as the MSI Oculux NXG253R (*see issue 327, p90*) will give you slicker results.

The OSD also gives you control over the RGB lighting built into the soundbar. In truth, it feels half-hearted, and because it's not part of a wider RGB system it will always be acting on its own.

Where the light bar becomes useful, however, is for controlling the soundbar volume. Press once on the bar and it lights up white to indicate the level (so, halfway indicates 50% volume), and then you can run your finger left or right to decrease or increase the volume. This isn't a soundbar to rival expensive add-ons for a living room TV, but I was pleasantly surprised by its quality. It coped admirably with the complex drum intro to Fleetwood Mac's "Tusk", and it's excellent when it comes to the mid-range, with melodic songs and even violin concertos coming through with great clarity. It was only in complex, multi-layered tracks by Björk where muddiness meant I missed having dedicated speakers.

"This isn't a soundbar to rival expensive add-ons for a living room TV, but I was pleasantly surprised by its quality"

BELOW The 1500R curvature is well suited to a 34in widescreen monitor

They're a great choice for films, too, and it helps that the screen is tuned to the movie-friendly DCI-P3 colour gamut. In its default mode, the MateView covered 88% of that colour space with an average Delta E of 0.96, which are fine results. Huawei doesn't offer any other presets, and the controls you do have – over contrast and colour temperature, for example – aren't exactly sophisticated.

In fact, I imagine the only control people will change is the brightness, with a peak of 434cd/m² in our tests. That's significantly higher than the 350cd/m² Huawei claims, but this still isn't a panel that makes HDR games or videos burst from the screen.

Nor is it the most flexible of displays, with only 110mm of height adjustment, no swivel and a basic amount of tilt. And while it's admirable to include a USB-C input for connecting laptops, I was surprised to see power delivery restricted to 10W – that's enough to trickle-charge a laptop, but rivals such as the Philips Brilliance 346P1C (*see issue 326, p93*) go up to 90W. There's also no USB hub. Two HDMI 2 ports and a DisplayPort connector round out the connections.

Considering the price, though, Huawei packs in the features. The Philips Brilliance costs around £60 more, and top-notch widescreen gaming monitors such as the MSI Oculux NXG253R are typically £700. If you don't need the soundbar then you can save £50 from the MateView's price, but it isn't a sacrifice worth making: for £500, this is a great buy for someone seeking a work screen during the day and an entertainer at night. **TIM DANTON**

SPECIFICATIONS

34in 3,440 x 1,440 MVA panel up to 165Hz ● 1500R curvature ● 10-bit panel (1.07 billion colours) ● 4ms response time ● DisplayPort 1.4 ● 2 x HDMI 2 ● USB-C (power delivery up to 10W) ● USB-C (for external power supply only) ● 3.5mm jack ● 2 x 5W soundbar ● 2 x mics ● -5° to 20° tilt ● 110mm height adjustment ● 808 x 220 x 442-542mm (WDH) ● 6.6kg ● 2yr RTB warranty

dynabook

Dynabook recommends
Windows 10 Pro for business

PC PRO TECHNOLOGY EXCELLENCE AWARDS 2021
WINNER
BUSINESS LAPTOP OF THE YEAR

intel.
evo
POWERED BY
CORE
i7

The world's lightest*
13-inch convertible

Discover the Portégé X30W.
Engineered to exceed Intel®'s exacting new Evo™ classification.

Intel® Evo™ Platform | Windows 10 Pro | 11th Gen Intel® Core™ Processors | Intel® Xe graphics | 989 Grams | Instant Wake <1s
15 hour battery life with quick charge | 2 x Thunderbolt™ 4 | Robust Magnesium Chassis tested to Mil STD 810G

uk.dynabook.com/X30W

*Based on 13.3" convertible laptops with 11th generation Intel® Core™ processors as of 2020/11/04, research conducted by Dynabook Inc.

Logitech Zone Wired Earbuds

An excellent, if expensive, way to ensure high-quality calls whether you're in your office or on your travels

SCORE ★★★★☆

PRICE £75 (£90 inc VAT)
from logitech.com

The Logitech Zone Wired Earbuds may well be the product you've been waiting for these past two years. Rather than wear a clunky headset for video calls, you can switch to wired earbuds with a built-in noise-cancelling microphone that you can use in busy environments. That gives it two clear selling points: it's great for Zoom calls with a virtual background, as the earbuds merge into your face; and of particular use to business travellers. Logitech even includes a handy pouch.

While I mention Zoom above, these earbuds are actually at their best for Teams users. Pressing the middle button on the in-line remote control launches Teams if you already have it installed, and the button's backlight will pulse if someone calls you via Microsoft's service, too. You can also use the control to mute yourself (the button lights up in an unmissable vivid red), while another button lets you pause or play music. A volume strip down the side completes the controls.

Sound quality will depend on how well the earbuds slot into your ears. Logitech does its best to accommodate everyone by including four sizes of tips, but my admittedly narrow ear canal would have liked the body of the earbuds to be even smaller. I found the tiniest tips to be usable, however, and that's better than most earbuds I've tried. Assuming you achieve the same physical result, you'll be rewarded with solid audio – its weakness is treble, with cymbals a hollow echo of themselves.

The bonus is that I found the earbuds comfortable enough to wear for an hour-long meeting without even thinking about them, and the dual noise-cancelling mics (built into the left earbud) are great at isolating your voice even in a noisy public space. It's not the purest audio – the algorithm's emphasis is evidently on clarity rather than capturing the Branagh-like depth of your tones – but it's effective. You can also take some control by downloading Logi Tune, which allows you to adjust the mic level and sidetone (how much of your voice you hear through the earbuds).

With a 1.5m cable and three connection options – 3.5mm jack, USB-C and USB-A – the Zone Wired Earbuds are a great weapon to add to your communication arsenal. They'll work with a phone or laptop, Windows or macOS, Android or iOS, and could be a meeting-saver if you need to make yourself heard. The obvious downside? At £90, they're ten times the price of perfectly serviceable wired earbuds. **TIM DANTON**

ABOVE Launch Teams with a press of the button on the remote

BELOW The Zone Wired Earbuds come with four sizes of tips

SPECIFICATIONS

Wired in-ear earbuds ● dual MEMS noise-cancelling mic ● 1.5m cable ● 3.5mm, USB-C and USB-A connections ● certified for Microsoft Teams, Google Meet, Google Voice and Zoom ● each earbud, 23 x 23 x 27mm (WDH) ● 2yr limited warranty

Logitech Pop Keys

We love the thinking behind the mechanical Pop Keys, but the typing experience isn't quite up to scratch

SCORE ★★★☆☆

PRICE £83 (£100 inc VAT)
from logitech.com

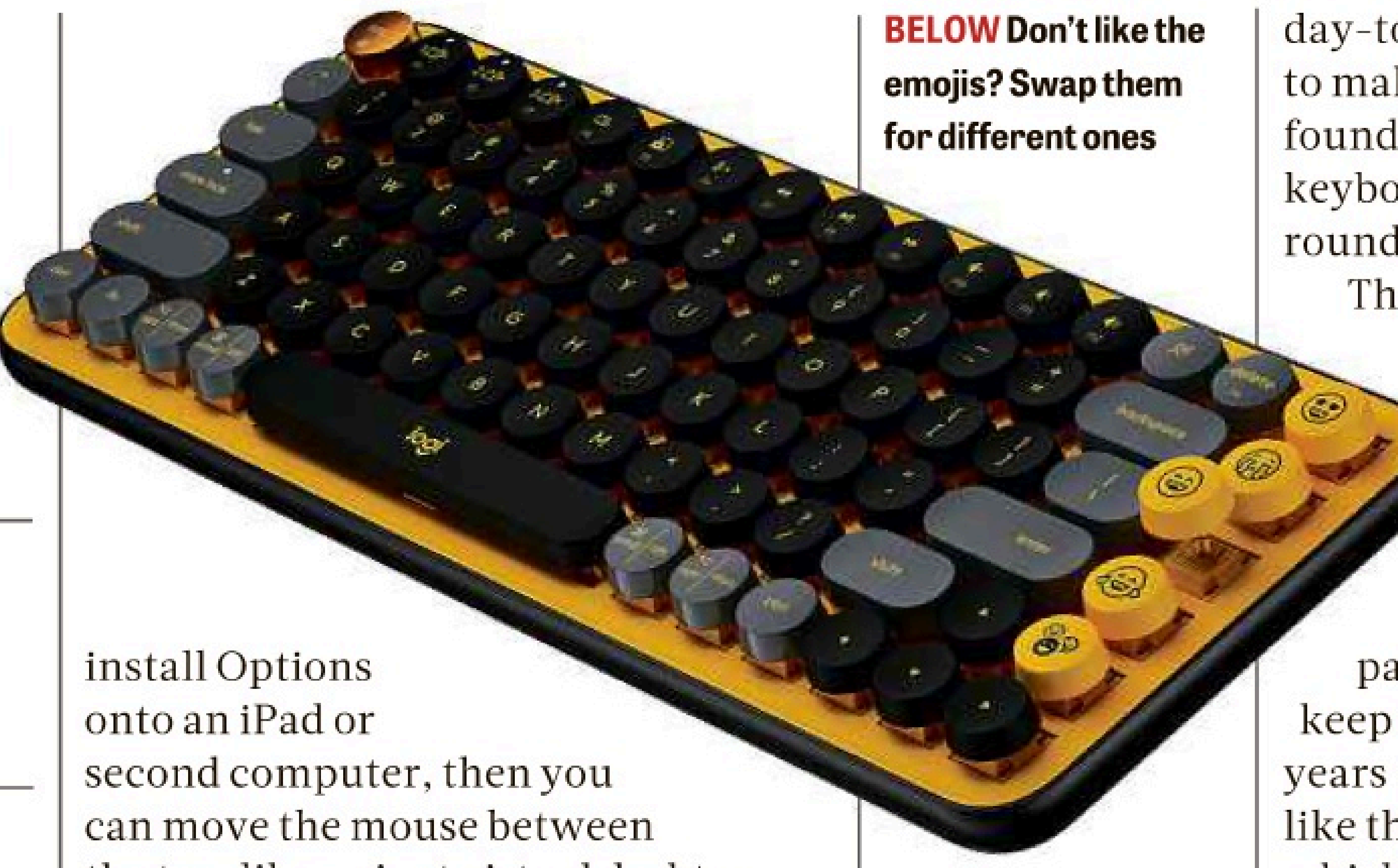
Do not adjust your sets: this is a Logitech keyboard, just not as you know it. Rather than the staid grey designs of its ever-brilliant MX series, the Pop Keys is available in a trio of eye-popping colours. And, as the photo shows, it includes a column of five emoji keys down the right-hand side. If Logitech's chosen set of emojis makes you ☹ then mix and match with the four others in the box until you're ☺. Simply rip the old ones off and slot the new ones on.

Logitech would earn itself an even bigger smile if its Options software was clever enough to automatically detect which buttons were in place, but instead this is a manual job. More positively, if you buy the accompanying Pop Mouse (£35) and install Options onto an iPad or second computer, then you can move the mouse between the two like a giant virtual desktop; both the mouse and keyboard will switch between computers. Or you can simply pair each computer with the keyboard, then press F1, F2 and F3 to manually switch the source. If you don't have Bluetooth, there's a Logi Bolt USB receiver in the box (the Pop Keys isn't compatible with Logitech's unifying receiver).

Logitech has opted to make this a mechanical keyboard. I have mixed feelings about this. I like the positive action of the brown switches (Logitech's own, but similar to Cherry MX Brown), and when I got into my rhythm I enjoyed the click and clack as I always do with mechanical keyboards. Sadly, in day-to-day use I found it all too easy to make typos. This isn't an issue I've found with conventional mechanical keyboards, so perhaps it's due to the round keytops or their shiny surface.

This is a shame, because otherwise there's much to like here. For instance, Logitech ensures the keyboard should look equally striking in years to come by printing the lettering onto the keys. The pair of AAA batteries will allegedly keep the keyboard going for three years (there's no backlight). I even like the flourish given to the Esc key, which is finished in metallic copper on the yellow-and-black "Blast" finish of my review sample. Then there's the compact design, which salvages extra space on a desk.

But we need to talk about the price. At £100, you have to absolutely ♥ the aesthetic to buy this keyboard. **TIM DANTON**



BELOW Don't like the emojis? Swap them for different ones

BELOW The Pop Keys is available in three striking finishes

SPECIFICATIONS

Bluetooth mechanical keyboard ● Logitech Brown mechanical switches ● Bluetooth 5.1 LE (10m range) ● three channels ● Logi Bolt USB receiver ● 2 x AAA batteries (supplied) ● supports Android 8, Chrome OS, iOS 11, macOS 10.15 and Windows 10 or later ● 321 x 138 x 35mm (WDH) ● 779g ● 1yr limited warranty

Reader offer

Full Windows 11 licence

Want to upgrade to Windows 11 but don't want to pay full price for the OS? Take advantage of our reader offer and you can save up to 59%

Boxshots for illustration purposes only

Are you in the market for a new copy of Windows 11? Perhaps you're building a new PC from scratch or looking to move up from Windows 7? Maybe you're planning to run Windows alongside macOS or Linux? Whatever your reasons, a Windows 11 OEM licence is a great choice.

The first reason is simple: price. Microsoft charges £120 for a retail licence of Windows 11 Home, and a staggering £220 for Windows 11 Pro. By choosing an OEM licence – and avoiding the many dubious sources of licences you may find online – you cut that price in half.

OEM stands for original equipment manufacturer, but that doesn't mean this licence is only an option for new system builders. Far from it, in fact. Although OEM licences can be used on one machine – once installed and activated, they're tied to that device – they otherwise work in exactly the same way as a full Windows 11 licence. That means unlimited Windows reinstalls and access to all future Windows 11 updates.

A fresh start

In fact, Windows 11 OEM is perfect for any kind of fresh install. It's the obvious choice for those building a new PC from scratch – the lower price means you save money on the cost of your build – but you may also need a fresh OEM licence if you've upgraded your motherboard with a different model. (Although we suggest you contact Microsoft first; it can often be lenient on this rule.)

An OEM licence also fits the bill if you want to run Windows alongside another operating system, either in a dual-boot configuration (such as a Boot Camp configuration on a Mac) or in a virtual environment such as VirtualBox, Parallels Desktop or VMware.

In either event, it's a far more cost-effective choice than splashing out on a full retail licence.

Version therapy

Windows 11 Pro includes all the new frills and features found in Windows 11 Home, plus important business functionality for encryption, remote login, creating virtual machines and more.

If you already own Windows 10 Home, you can upgrade to Windows 11 Pro using the OEM licence and benefit from additional features such as BitLocker. This offers system-wide data protection by encrypting your drives, including external ones such as USB keys.

Then there's Assigned Access, which gives greater control over what users are able to do on a system, while Hyper-V allows you to run a virtualised operating system within Windows without the need for extra software, such as an insider build of Windows 11, a Linux distro or even older editions of Windows. There's a reason why enthusiasts go Pro!

One final note: please remember to check your PC can run Windows 11 before purchasing. Head to **pcpro.link/healthcheck** and Microsoft's PC Health Check App will download automatically.

Microsoft
Windows 11 Home
Windows 11 Home
£59.99
save
50%

Microsoft
Windows 11 Pro
Windows 11 Pro
£89.99
save
59%

Buy from the *PC Pro* store at pcpro.link/win11pro

Huawei Watch GT 3

A stylish smartwatch that offers plenty of advanced fitness features along with impressive battery life

SCORE ★★★★☆

PRICE **42mm, £175 (£210 inc VAT) from consumer.huawei.com**

7645
LON
FRI

ABOVE The stainless steel and toughened glass belie the watch's fitness credentials

Several companies make stylish smartwatches; several make functional fitness-focused smartwatches. With the Watch GT 3, Huawei manages to hit the Venn diagram bang in the centre.

To look at, you wouldn't think this watch was geared towards fitness at all. Its bright AMOLED touchscreen display is set in a lightweight stainless steel and plastic case, and topped with toughened glass that has a curved edge to creates the illusion of extra screen space. It comes with a variety of strap options, including silicone, metal and leather (shown here).

The watch comes in two sizes: 42mm and 46mm. The larger version has a 1.43in display with a case that's 11mm thick, and weighs 43g without the strap. The smaller model has a 1.3in display with a 10.2mm thick case, and weighs 35g. That's lighter than the Apple Watch Series 7 (*see issue 327, p71*).

LEFT The Watch GT 3 includes a wealth of useful fitness features

Battery life is the biggest difference between the GT 3's two watch sizes: the 46mm version lasts up to 14 days on a single charge, while the 42mm model lasts seven days. When I used the 42mm model, tracking an average of one workout per day, the battery needed recharging after six days – highly respectable for a sensor-packed AMOLED smartwatch.

And it's certainly packed. It offers location tracking via GPS, Beidou, GLONASS, Galileo and QZSS, helping to pinpoint your location in built-up areas and remote locations alike. The updated heart-rate monitor is even better: it responded quickly to changes in intensity during tough interval sessions on a spin bike, for instance, and results were accurate to within around 5bpm compared with measurements from a chest strap heart-rate monitor.

There's no ECG, but the SpO2 sensor can be used continuously or to perform spot checks – a welcome option that helps extend battery life – plus stress tracking and a skin temperature sensor. That's something you won't find on an Apple Watch.

Like the recently released Garmin Venu 2 Plus (*see our CES feature from p26*), the Huawei Watch GT 3 has a microphone that allows you to receive calls from your wrist. Unlike Garmin's watch, however, the GT 3 also lets you initiate calls when connected to your phone's address book. It supports music, too: you can save your own songs locally or use it as a remote to control music playback on your phone.

One feature that's conspicuous by its absence, however, is contactless payments. That's a real shame, and puts Huawei on the back foot compared to rivals such as Apple, Fitbit, Garmin and Samsung.

Where it strikes back is its wealth of fitness features. There are over 100 workout tracking modes, but running is where it really shines. For example, with a couple of taps in the accompanying Huawei Health app, you can create a video that plays back your route, ready to send via your messaging app of choice. But its real standout feature is its "AI running coach", which lets you set a goal in the app and then generates a training plan based on your height, weight, age, current training load and personal bests. The only drawback is that you can't create a plan for an event more than four months in future, which is an issue for marathon training.

Once you've created your plan, you can sync the resulting sessions with your calendar, and access it through the "Courses and plans" section of the workout app on your watch. Each workout completed will be logged in the app and your plan tweaked on the fly as you go along.

This is all very slick, but I did hit a hurdle when I first loaded up the Huawei Health app via Google Play: it didn't recognise the watch. I had to head to Huawei's own app store, AppGallery, and download it from there.

Once in place, the app is easy to navigate. I particularly like its "Healthy Living Shamrock", which is a clover-shaped diagram with leaves representing different goals – step count, mood (via breathing exercises) and sleep. Setting your own targets makes the Shamrock a genuinely useful tool for managing life's daily stresses and strains.

The selection of downloadable apps for the watch is limited, but there are some gems. The navigation app that uses Google Maps is particularly well implemented, providing turn-by-turn directions on your wrist so you don't have to carry your phone in your hand in public.

> **"The navigation app provides turn-by-turn directions on your wrist so you don't have to carry your phone in your hand"**

At the time of writing, all the third-party apps are free.

I was also pleased to see that all of Huawei's own tools are available free of charge, including the AI training tool. Unlike Fitbit, Huawei hasn't locked certain features behind a subscriber-only paywall.

The lack of apps compared to its rivals and no wrist payment option mean this smartwatch falls just short of a Recommended award, but if you can live without third-party apps, then it's a superb option. **CAT ELLIS**

Celia
123 4567 8910

BELOW A microphone and speaker mean you can make and receive calls from your wrist

SPECIFICATIONS

Shared: 4GB storage ● mic and speaker ● GPS ● Bluetooth 5.1 ● heart-rate sensor ● gyroscope ● geomagnetic sensor ● air pressure sensor ● temperature sensor ● 5ATM water resistance ● Harmony OS Lite ● 2yr RTB warranty. **42mm:** 1.32in 466 x 466 AMOLED display ● 42.3 x 10.2 x 42.3mm (WDH) ● 35g. **46mm:** 1.43in 466 x 466 AMOLED display ● 45.9 x 11 x 45.9mm (WDH) ● 43g

Your bonus software

Total value this month £142

We scour the globe to negotiate the best software deals for our readers, from extended licences to full programs you don't need to pay a penny for. Here's this month's lineup

O&O DiskImage 16 Professional

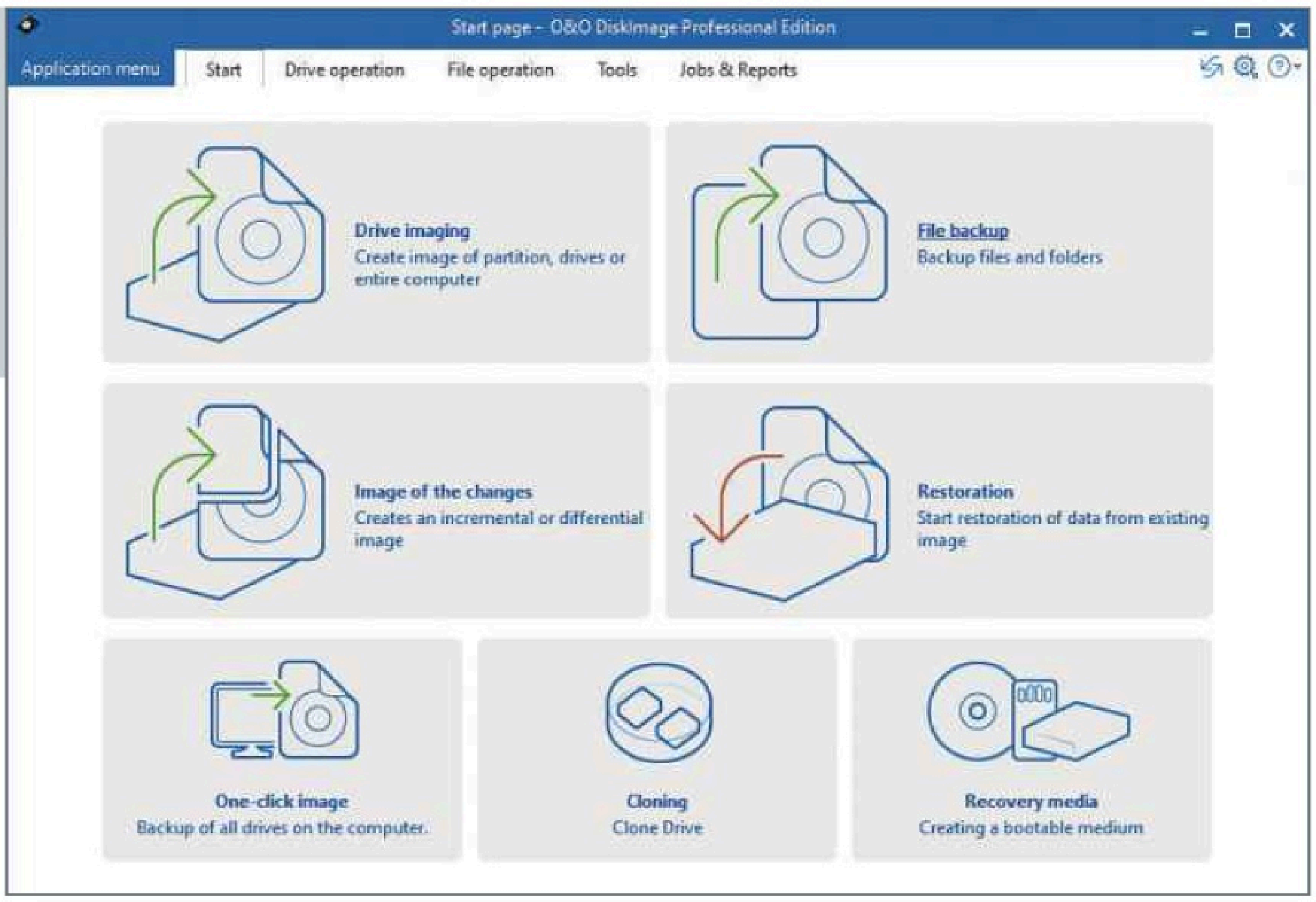
- **Full product worth £29**
- **oo-software.com**

REQUIRES
Windows 8 or later; 250MB hard drive space; online registration

We all know how important it is to maintain a fallback copy of Windows – with all your carefully configfured apps and settings – as well as your personal documents, media and other files. O&O DiskImage Professional provides all the tools you need to make regular backups of your files and folders, along with entire drives and disk partitions.

Once the software is installed, you can choose a backup mode, or select a source drive or volume and run a backup using the default settings. You can also browse individual files and folders, and tick the ones you want to protect as you go. There are options to run incremental or differential backups, compress or encrypt your archives, and more.

When you need to recover your data, you can restore disk and partition images, select individual files and folders, or mount an image file in Windows and browse it like an attached drive.


Start page - O&O DiskImage Professional Edition
Application menu
Start
Drive operation
File operation
Tools
Jobs & Reports
Drive imaging
Create image of partition, drives or entire computer
File backup
Backup files and folders
Image of the changes
Creates an incremental or differential image
Restoration
Start restoration of data from existing image
One-click image
Backup of all drives on the computer.
Cloning
Clone Drive
Recovery media
Creating a bootable medium

How to claim your bonus software

1 Visit **pcprodownload.co.uk.** You'll need to enter the coupon code printed on the spine of the cover (or directly on the cover if you're a digital subscriber). If there's no code on the spine, you have bought the £4.99 version of *PC Pro*, which doesn't include a code. Also enter your email address. We'll then send an email to confirm that your code has been registered.

2 Once you're in the download area, you can access this month's bonus software by navigating to the relevant product page and clicking the red Install button. For trial software, freeware and other downloads, click the Install button below the product description, or follow the onscreen instructions (please make sure to read these carefully).

3 If the software needs registering, click the purple Register button, or follow the instructions on the left of the product page (again, please read these carefully). In some cases, you may need to register for a *PC Pro* software store account – if you don't already have one – and you might be prompted to reenter the coupon code on the spine or cover.

4 Please be sure to install and register your bonus software before the date that's specified below. After this date, we can't guarantee that it will still be possible to download or register this issue's bonus software.

Remember to claim your software by 31 March 2022

pcprodownload.co.uk

Any problems?

If you need assistance with the coupon code or have registration issues, please contact us at **software@pcpro.co.uk**

Backup4All 8 Standard

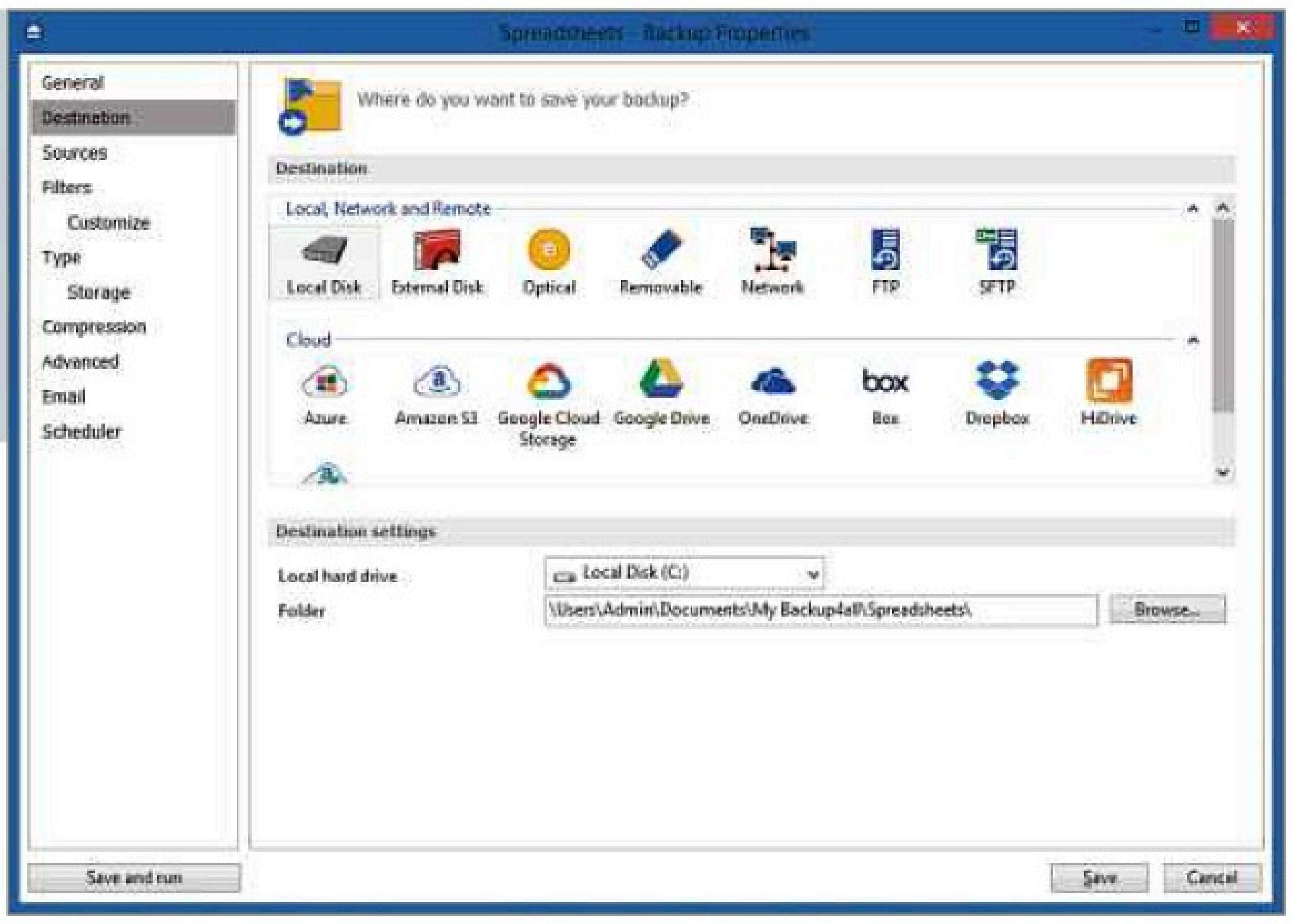
- **Full product worth £35**
- **backup4all.de**

REQUIRES Windows 7 or later; 30MB hard drive space; online registration

This latest edition of Backup4All Standard improves on its predecessors with enhanced file-copy options. There's support for differential backups (copying only new or changed files), and you can store multiple versions of a file, for both full and differential backups. It can also back up from network drives, and save your archives to optical media, with an option to run custom actions both before and after your backup operations.

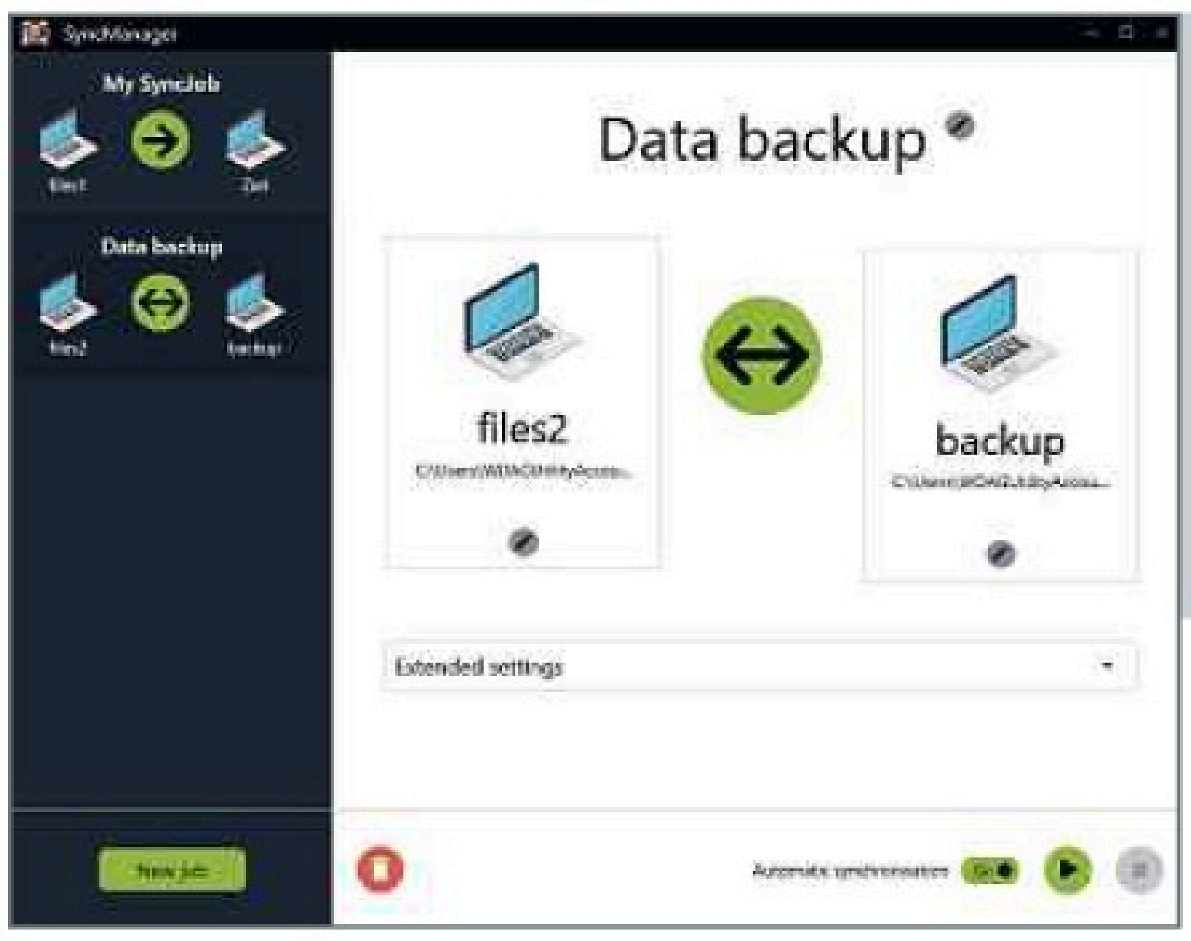
Recovering your files couldn't be simpler, as your backups are mirrors of the original files and folders, stored in regular Zip files. Simply open a folder in Windows File Explorer and you'll be able to find and recover what you need in seconds.

As well as new backup features, version 8 of Backup4All brings a revamped, more customisable and easier-to-user interface. You can now suspend, cancel or stop all backup jobs with a click, and the program can run scheduled jobs it might have missed. There are also new tools to test and repair your backups, so you can be sure of the integrity of your backups.


Spreadsheets - Backup Properties
General
Destination
Sources
Filters
Customize
Type
Storage
Compression
Advanced
Email
Scheduler
Where do you want to save your backup?
Destination
Local, Network and Remote
Local Disk
External Disk
Optical
Removable
Network
FTP
SFTP
Cloud
Azure
Amazon S3
Google Cloud Storage
Google Drive
OneDrive
Box
Dropbox
HiDrive
Destination settings
Browse...
Save and run
Save
Cancel

Local hard drive: Local Disk (C:)
Folder: \Users\Admin\Documents\My Backup4all\Spreadsheets\

SyncManager 2021

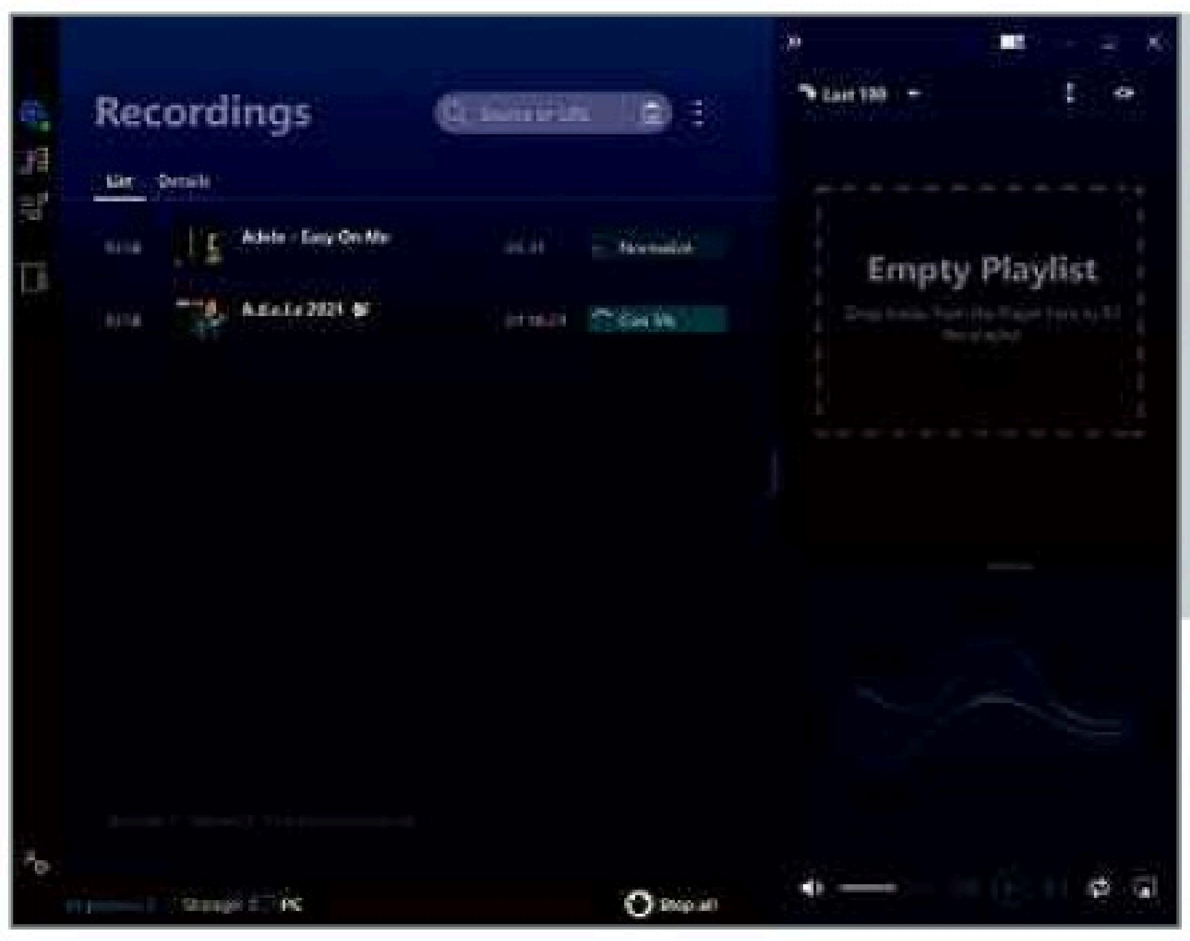

SyncManager
My SyncJob
Data backup
files2
backup
Extended settings
New job
Automatic synchronisation

- **Full product worth £30**
- **abelssoft.net**

REQUIRES Windows XP or later; 30MB hard drive space; online registration

- Define your own custom rules to back up and synchronise your files to any destination you like
- Synchronisation can happen as soon as files change, daily, weekly or on demand – it's entirely up to you
- A friendly wizard-like interface guides you through the process, to get you up and running in moments

Music 2022 SE

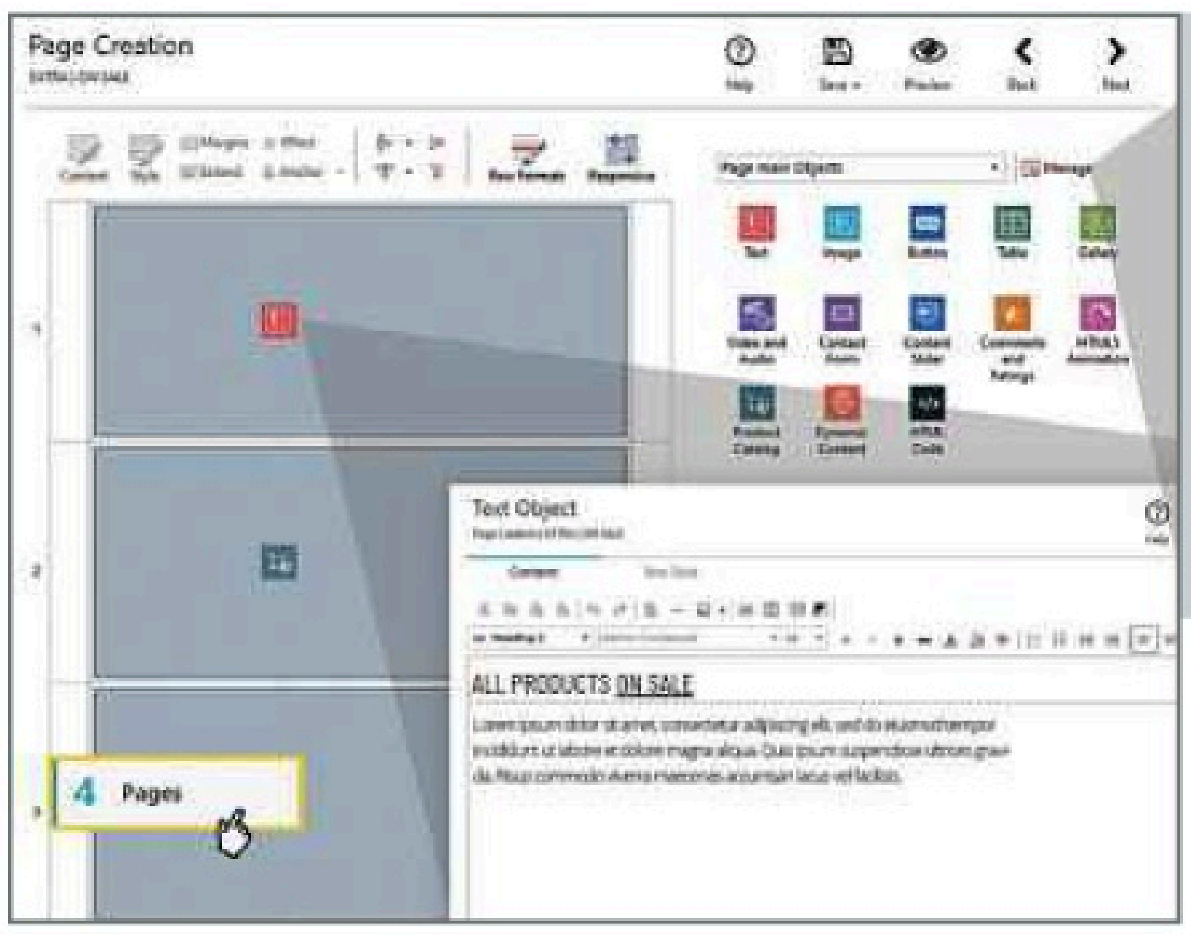

Recordings
Empty Playlist

- **Full product worth £18**
- **audials.com**

REQUIRES Windows 7 or later; 250MB hard drive space; online registration

- Find elusive audio tracks online, stream them live, or download them to your computer
- Brings all of your music together into one library, no matter where it's stored on your PC
- Can also be used to download music videos and convert them into a format you can play on your computer

Website X5 Go 2021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Text Object
ALL PRODUCTS ON SALE
4 Pages

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REQUIRES Windows 7 or later; 300MB hard drive space; online registration

- Create high-quality, responsive websites in minutes, with no coding experience required
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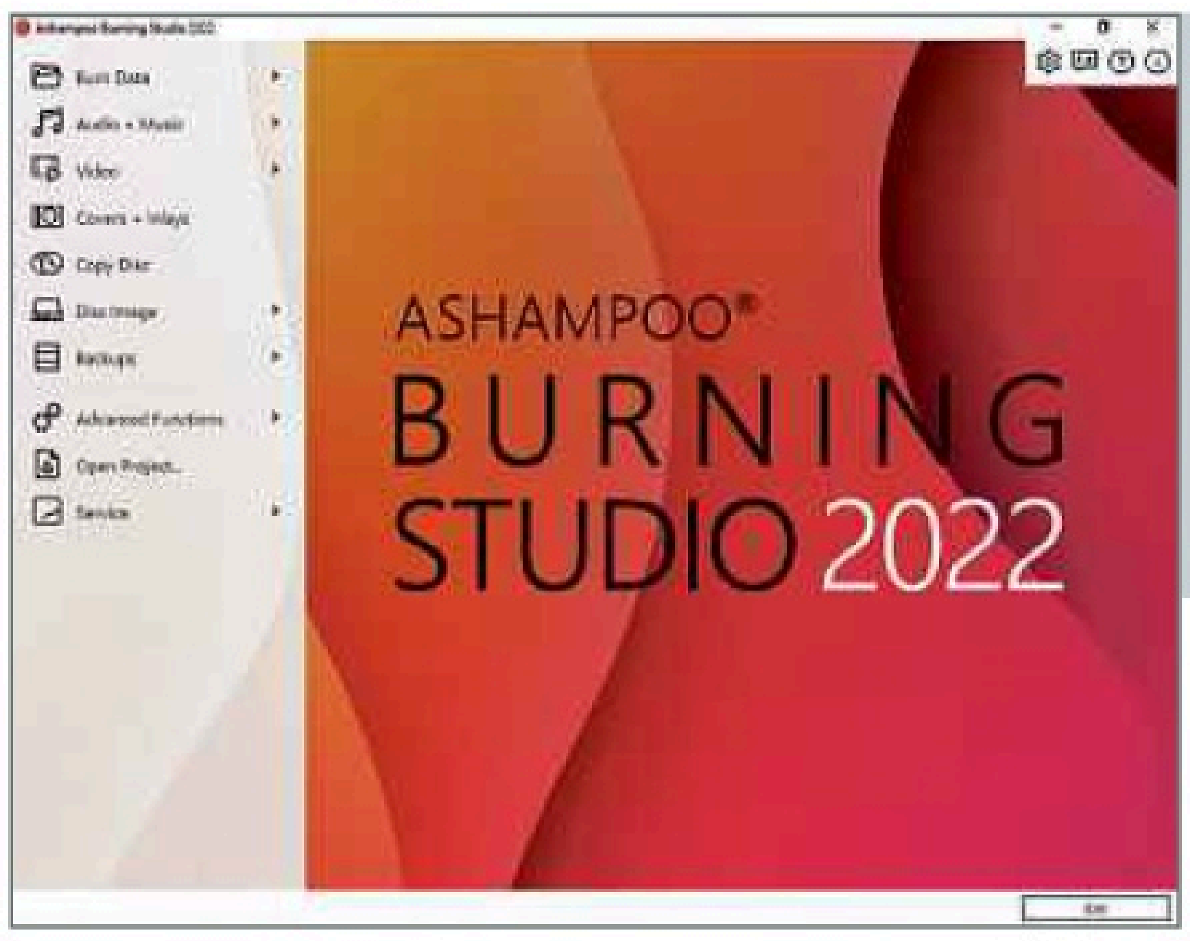
- Add text blocks, image galleries, video and audio widgets, tables, animations and email forms to complete your site

Burning Studio 2022


ASHAMPOO®
BURNING STUDIO 2022

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- **ashampoo.com**

REQUIRES Windows 7 or later; 200MB hard drive space; online registration

- The easy way to burn CD, DVD and Blu-ray discs. Choose your project type, then drag and drop your files
- Create autostart discs with interactive menus, or that launch documents, open web links, send emails and more
- Also includes a simple file-backup tool, cover designer and disc copier for one-stop duplication

Motorola Moto G31

The lack of 5G – and speed – holds it back, but the Moto G31 is comfy to hold and offers long battery life

SCORE ★★★☆☆

PRICE **64GB, £142 (£170 inc VAT)** **from motorola.co.uk**

ABOVE **Curved edges and a textured rear make the Moto G31 comfortable to hold**

The cheaper end of the smartphone market is increasingly cluttered, but Motorola hopes to cut through the sludge with its Moto G31. By ignoring 5G, its tactic is to concentrate on more visible aspects of the device – think design and screen – while stuffing in a whopping great battery to keep it going for two days.

It's the build of the phone that will likely delight you most. Offering curved edges and a textured rear, it felt good to hold and secure in my hands (which are smaller than most people's, so normally aren't fond of big phones). Motorola sent us the "mineral grey" model to review – it's also available in "baby blue" – and it looks classy despite its plastic body.

Along with the usual buttons for volume and power, you'll find a fingerprint reader on the right-hand side. The reader would have felt more comfortable on the back, but it means that the rear of the phone has a minimalist air, other than the camera lenses in the top left-hand corner. The textured plastic body means no risk of fingerprints either, so it looks good no matter how long you've been using it for.

LEFT **The G31 is available in blue and grey finishes, both of which look stylish**

The bottom holds the USB-C charging port and a speaker, but you'll search in vain for a headphone jack. And while there is some water resistance, it's the minimal IPX2 rating (drops of water at a 15° angle) so this is a phone to keep well away from the beach.

Then we come to the second prize inclusion of this phone: its AMOLED display. Thanks to this, the Moto G31 offers vibrant colours and deep blacks. It's ideal for watching streaming video, capturing all the colours how you'd like them to be. A sharp resolution of 1,080 x 2,400 helps, too, although I was a little surprised to see it stuck at 60Hz refresh rates when other budget phones offer 90Hz. Not that this is a deal-breaker: I didn't notice any obvious visual lag when playing games or watching videos. The only thing I wished for was more brightness, as it struggled in bright sunlight.

A punch-hole at the top of the screen offers up the selfie camera lens, but it takes up the bare minimum of space – it's literally just the lens. This is one of four cameras on the G31, but only the main 50MP unit is anything to shout about. Photos taken in daylight offer natural colours and reasonable dynamic ranges, and while the HDR setting can make images over-vibrant, it's certainly eye-catching.

Things start to falter when you switch to the other cameras. The ultra-wide sensor helps with group shots, but it often produced blurry photos in my tests. Blurriness is also the theme for low-light photos. Switch night mode on and things certainly look brighter than you might expect, but the results aren't always realistic. The macro camera is simply pointless, but that's often the case with cheaper phones.

On the plus side, selfies come out well and the Moto G31 offers plenty of great software options that are easy to find and select when you want to use them. In fact, software is a plus point overall: Moto offers a clean Android 11 experience that's genuinely enhanced by the familiar Moto gestures.

The Moto G31 uses the MediaTek Helio G85 chipset, which was only enough for 345 in Geekbench 5's single-core test and 1,311 in the multicore section. That's fine – just about – but it's disappointing that the G31 is outperformed by older phones such as the Moto G50 (*see issue 323, p75*). This scored 504 and 1,637, helping the G50 to feel significantly smoother in use; it helps that the G50 includes a 90Hz screen, even if it's a less vibrant IPS panel.

With 4GB of RAM for support, the G31 isn't a phone designed for multitasking, but it can do it in a bind. Similarly, it can cope with gaming but gets hot when doing so.

Assuming you aren't gaming, though, you can expect amazing stamina. In fact, the 5,000mAh battery kept it going for a couple of days without any trouble during my testing. The only downside is that recharging is slow going at 10W, and there's no wireless charging support.

So, should you buy the G31? With the 64GB variant costing £170 and 128GB at £190, it's tempting if your priority is ease of use, comfort in the hand and sheer longevity. And I would expect the G31 to be discounted in the coming months (it only became available to buy in December 2021, so is still in its honeymoon period).

> **"With the 64GB variant costing £170 and 128GB at £190, it's tempting if your priority is ease of use and sheer longevity"**

Ultimately, however, the Motorola Moto G31 falls short of a recommendation. I can't ignore the 5G omission, which will become a bigger issue over the coming months, and perhaps more important are its lack of speed or ruggedness. Motorola would be right to point out that you have to make compromises at this price, and you will still be making them if you choose the G50: it has a lesser screen, for instance, and shares the G31's mediocre camera. But, of the two, it's more likely to give you satisfaction over the lifetime of the phone. **JENNIFER ALLEN**

SPECIFICATIONS

8-core 2GHz/1.8GHz MediaTek Helio G85 ● 4GB RAM ● Mali-G52 graphics ● 6.4in 60Hz AMOLED screen, 1,080 x 2,400 resolution ● 64GB/128GB storage ● 50MP/8MP/2MP rear cameras ● 13MP front camera ● Wi-Fi 5 ● Bluetooth 5 ● NFC ● 3.5mm jack ● microSD slot ● USB-C connector ● 5,000mAh battery ● Android 11 ● 73.9 x 8.6 x 162mm (WDH) ● 181g ● 1yr warranty

Samsung Galaxy S21 FE

If Samsung slashes the price, this could be a fine mid-range phone. Right now, it's massively overpriced

SCORE ★★★☆☆

PRICE **128GB, £583 (£699 inc VAT) from samsung.com**

ABOVE **The 6.4in AMOLED screen is surrounded by an incredibly thin bezel**

The Samsung Galaxy S21 FE really challenges the idiom "better late than never": arriving almost a year after the other phones in the S21 family, the FE lands as we await news of the Galaxy S22 range. This Fan Edition is purportedly the budget member of the Galaxy S21 range, but, right off the bat, price is a problem. At £699, it's almost identical to the street price of the S21 (*see issue 318, p68*).

You'd be forgiven for confusing the Galaxy S21 FE with its non-FE sibling: other than its larger size, it's a dead ringer. Until you touch it, that is, for this is a plastic rather than metal phone. The positive to this is that it's less prone to scratches and easier to grip, but it feels cheaper than the S21. It shares the S21's strikingly slender design, though, and you have to admire the barely-there bezel around the 6.4in AMOLED panel.

This positions the FE between the 6.1in S21 and 6.7in S21 Plus in the family line-up. Like its sibling, the display has a 1,080 x 2,400 resolution and 120Hz refresh rate. Another point of similarity is Samsung's Dynamic AMOLED 2X technology, which ensures the screen is both vibrant and bright. Streaming TV shows and playing games on the phone is a treat.

Breaking up the display is a cut-out for the front-facing camera along the top edge, which is an upgrade on the S21: 32MP rather than 22MP. Snaps looked bright and detailed, even in low-light settings, but I avoided the Portrait mode owing to its sometimes inaccurate application of bokeh blur.

LEFT **Don't like grey? Then choose olive, lavender or good old-fashioned white**

The main 12MP camera and 12MP ultrawide lens are both holdovers from the S21, but while the S21 also has a 64MP telephoto camera, the FE makes do with 8MP. Still, it's paired with the same lens, which allows for 1.1x optical or 3x hybrid zoom; few will notice the difference in practice.

Pictures taken on the main camera were extremely colourful, as you'd expect from a Samsung phone; I suspect the brand's scene-optimisation software has never heard of oversaturation. The results are instantly social media-worthy, especially when taken in well-lit situations.

I also appreciate how pictures taken on the three different cameras share a colour profile. Many phone cameras don't have these in sync, so jumping between a zoom and standard shot can affect how colours and brightness look. For the S21 FE, no matter what zoom level I picked, shades looked the same.

Both the front and rear cameras can hit 4K resolution and 60fps, which is a surprise for the front camera as few phones hit 4K selfie recording. The Galaxy S21 can actually record 8K video, so the FE will disappoint the few people in the world who want that on a phone.

The FE makes no sacrifice on speed, with the same Exynos chip as the S21. That's the chip in European phones, at least, but Samsung sent us a unit with the Snapdragon 888 found in the US versions. In practice, there's little difference: this is a stupidly quick phone for general use and gaming. However, I expect the S22 family to shift up yet another gear to the newly unveiled Snapdragon 8 Gen 1 SoC.

The S21 FE runs Android 12, with Samsung's One UI 4 laid over the top. The 8GB of RAM (6GB on 128GB variants), processor and screen refresh rate should have made navigating the FE's menus a breeze, but swiping between home pages, opening apps and unlocking the phone felt sluggish. In particular, using the menu's search function to find a particular app was often laggy. This should be solved by an update, though, and this sluggishness was only an issue for the phone's menus. When using apps, the phone felt snappy.

I was also surprised by the poor battery life, especially with a 4,500mAh unit inside. With average use – some social media browsing, music streaming and the odd game and photo capture here and there – I found the battery barely survived a day between powering. Heavy use meant I needed to charge the mobile in the early evening to keep it ticking until the next morning.

The FE's 25W charge rate is also uncompetitive compared to some of the fast-charging phones on the market, many of which go up to 65W or even 120W. At 25W, the FE takes about an hour-and-a-half to go from empty to full. A charger isn't included in the box, either.

> **"Pictures taken on the main camera were extremely colourful, as you'd expect from a Samsung phone"**

More positively, the Galaxy S21 FE also offers 15W wireless powering and 4.5W reverse wireless powering, the latter of which lets you juice up other mobiles. Those aren't fast speeds either, but at least the options are there.

So, where does this leave the S21 FE? In short, overpriced. The only advantage it offers over the S21 is its larger screen, but otherwise the older phone is better specified in every way. **TOM BEDFORD**

SPECIFICATIONS

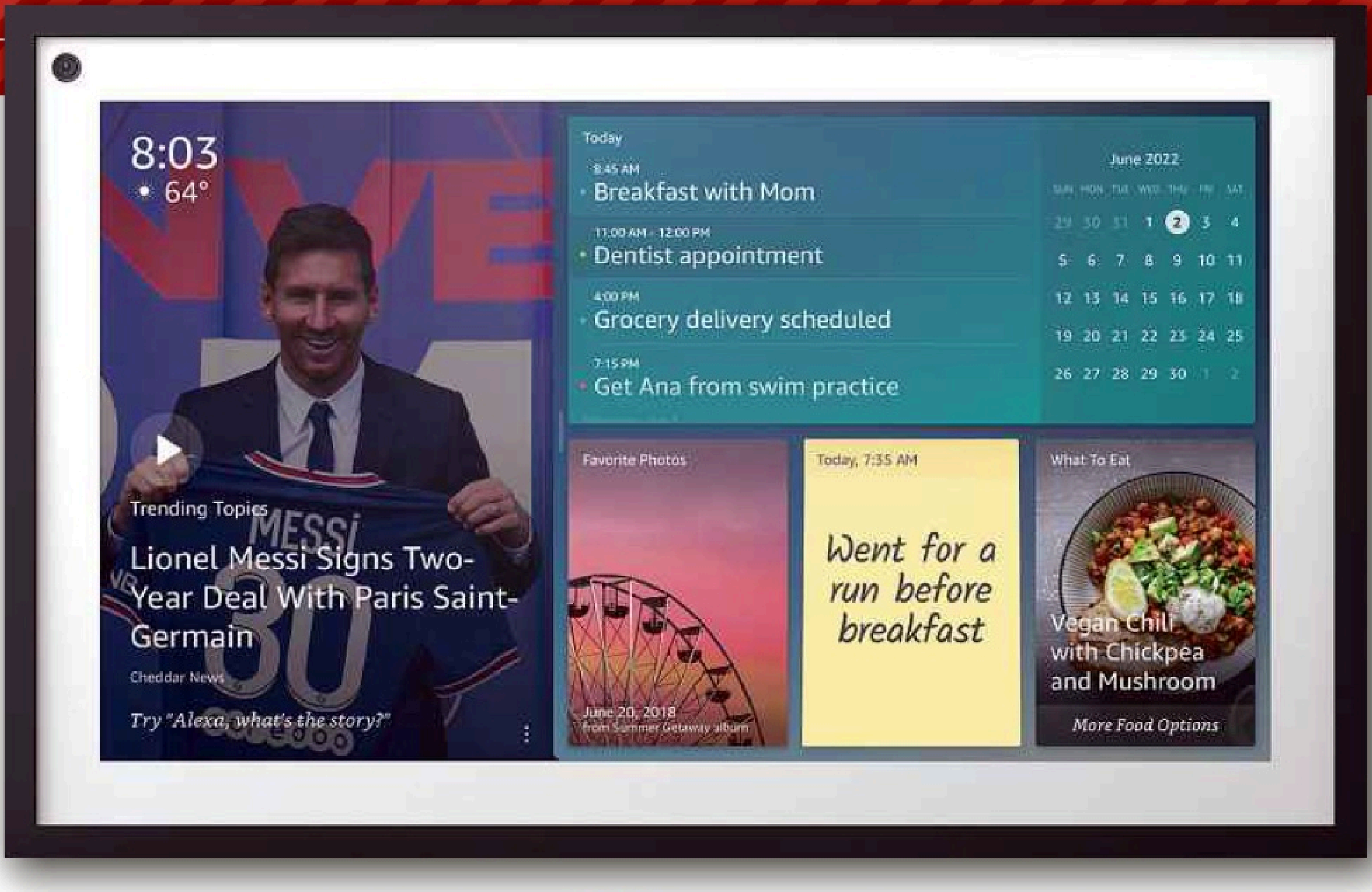
8-core 2.84GHz/2.42GHz/1.8GHz Qualcomm Snapdragon 888 5G ● 6GB/8GB RAM ● Adreno 660 graphics ● 6.4in 120Hz AMOLED screen, 1,080 x 2,400 resolution ● 128GB/256GB storage ● 12MP/8MP/12MP rear cameras ● 10MP front camera ● Wi-Fi 6 ● Bluetooth 5 ● NFC ● USB-C connector ● 4,500mAh battery ● Android 12 ● 75 x 7.9 x 156mm (WDH) ● 177g ● 1yr warranty

Amazon Echo Show 15

The Show 15 doesn't quite fulfil its potential, but it's a fine addition to a smart home if you accept its limitations

SCORE ★★★★☆

PRICE £200 (£240 inc VAT)
from amazon.co.uk


8:03
64°
Trending Topics
Lionel Messi Signs Two-Year Deal With Paris Saint-Germain
Cheddar News
Try "Alexa, what's the story?"
Today
8:45 AM
Breakfast with Mom
11:00 AM - 12:00 PM
Dentist appointment
4:00 PM
Grocery delivery scheduled
7:15 PM
Get Ana from swim practice
June 2022
Favorite Photos
June 20, 2018
from Summer Getaway album
Today, 7:35 AM
Went for a run before breakfast
What To Eat
Vegan Chili with Chickpea and Mushroom
More Food Options

ABOVE Widgets are a new addition to the Echo Show range, to mixed effect so far

What a brilliant idea the Echo Show 15 is. Where the previous Echo Show devices have been tabletop affairs, the Show 15 is at its best hanging on a wall – next to the fridge, perhaps, as Amazon hopes it will become the fulcrum of family life. You can buy the optional stand (£35) and sit it on your desk like a traditional Echo Show, but that feels like a waste of its talents.

So, where to put it? Amazon's advice is to keep the Show 15 at eye level. It comes with a "mounting template" (a posh word for a piece of paper with the Show's outline on it) and, once you work out your preferred area, you drill holes and mount it. All the wall plugs and screws come provided.

When it comes to software setup, the only variation from the usual Echo routine is that you're asked which images you'd like to display, with choices such as an Amazon photo album, abstract shapes and "art". Aside from entering your Amazon account details and Wi-Fi password, that's it; the Echo Show 15 will download an update (around ten minutes in my case) and then await your instructions.

You've been framed

This gives you time to admire the Echo Show 15's design. It's essentially a picture frame that's been pumped with steroids, with inch-thick white surrounds and a chunky frame. But where there would normally be a print, this frame contains a 15.6in touch-sensitive panel.

The Show 15 measures 35mm from back to front, with a bevelled edge that holds speakers on the left and right side (or top and bottom if you mount it vertically). That means it juts out from the wall a good inch further than any picture frames it may sit near, and unless you have a white-painted wall you'll also notice the thin cable that connects to a plug.

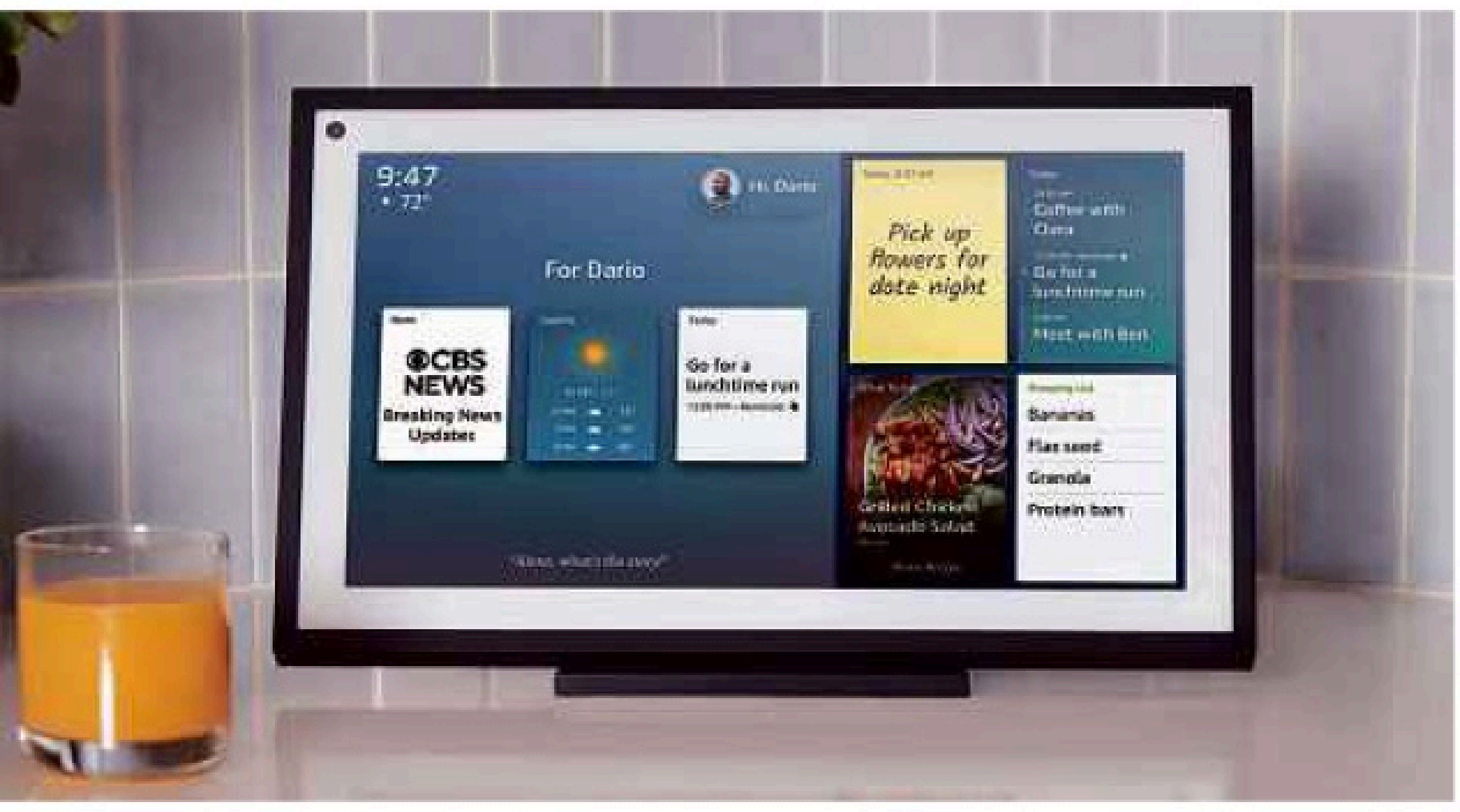
Amazon sensibly provides a cutout in the frame so you can curl away any excess cable, but most people will face the opposite problem. At 1.5m long, you may need to run an unsightly extension plug to the nearest socket.

Picture not perfect

There are a couple of other problems for anyone intending to use the Echo Show as a faux picture frame, which is that Amazon is still stuck in its "digital photo display" thinking. Cycling through a new image every few seconds is fine for photos, but it's annoying if you want to admire a piece of art or show a static image. You can say "Alexa, pause", but that only holds the image in place for around 30 seconds.

The single hack I could think of was to instruct the Echo Show to display an album that only contains one photo, but this is hardly ideal. Of course, Amazon may introduce static images with a software update, but there's no guarantee of this.

ABOVE Amazon is keen to push privacy features such as the camera shutter


9:47
72°
Hi, Dario
For Dario
Pick up flowers for date night
CBS NEWS
Breaking News Updates
Go for a lunchtime run
Grilled Chicken Avocado Salad
Coffee with Clara
Bananas
Flax seed
Granola
Protein bars

LEFT The Echo Show 15 on the optional stand – it can be placed vertically here, too

What happens if you simply leave the Echo be? It will cycle through available images but overlay the time, date and temperature. This is standard behaviour for Echo Shows, but it's a shame Amazon hasn't had a more radical overhaul.

It has made efforts to take advantage of the larger display, however, with its selection of widgets on the homescreen being the most obvious. Now, don't get excited. At the time of writing, a paltry 12 widgets were on offer, and most are dull: a shopping list, to-do list, sticky notes, Cookpad's recipe of the day, the Amazon calendar. The latter is the most useful, and unlike most of the widgets can be resized from small to large so that it fills the top section of the display. Widgets definitely have potential, but right now they're underwhelming in both number and utility.

PC PRO RECOMMENDED

Touch and go

Naturally, you can control most aspects of the Echo Show by voice. It had no problem hearing my commands; the big issue is whether it correctly interprets them. There's a good reason that people prefer Google Assistant over Alexa, as it remains better at understanding people's meaning. Alexa is perfect if you hit its keywords spot on, but it doesn't take much to make her say, "Sorry, I don't understand".

That's why I often defaulted to the touchscreen controls instead, which are organised in logical fashion. This is essentially a Fire OS device, so a heavily skewed version of Android, and there isn't much room for customisation. That means you will soon either find the setting you want or, more likely, discover it doesn't exist.

> "If you've resisted smart-home technology before, the Echo Show 15 may inspire you to kit out your home or office"

For example, you may search fruitlessly for a way to add third-party video services, but only Prime Video and Netflix are currently on offer. YouTube results will also be displayed after a search, but selecting them loads the Silk web browser rather than its own app. Likewise BBC iPlayer. Both played fine, but when I tried to watch an Australian Open match via my Discovery+ account, I was met with a "Mobile Guard: Android" error and (unlike on normal Android devices) there was no way around this.

Video star?

Admittedly, the Echo Show wouldn't be my top choice for TV viewing anyway. It faces a couple of key challenges, one of which is the glossy finish to the screen; I couldn't see any sign that Amazon has applied an anti-glare finish to alleviate this. The second is that the panel itself is basic. It covers only 55% of the sRGB gamut and 40% of DCI-P3, while its colour accuracy is poor with an average Delta E of 5.06. High-quality panels will have an average Delta E of less than 1.

There are two figures to cling onto, however, and those are its peak brightness of 439cd/m^2 and a fine contrast ratio of 1,973:1. It still isn't a screen I'd choose to watch *Blade Runner* on, but it's more than good enough for viewing cooking videos, football highlights and the latest news.

It's easy to be critical of the Echo Show 15's audio output as well, but I was pleasantly surprised by what Amazon has achieved. The speakers are at their most effective when they have a wall to bounce against, but even in the stand they produce room-filling sound. Don't expect hi-fidelity audio to match the best Echo speakers; instead, think of it as a way to listen to music in the background while preparing dinner.

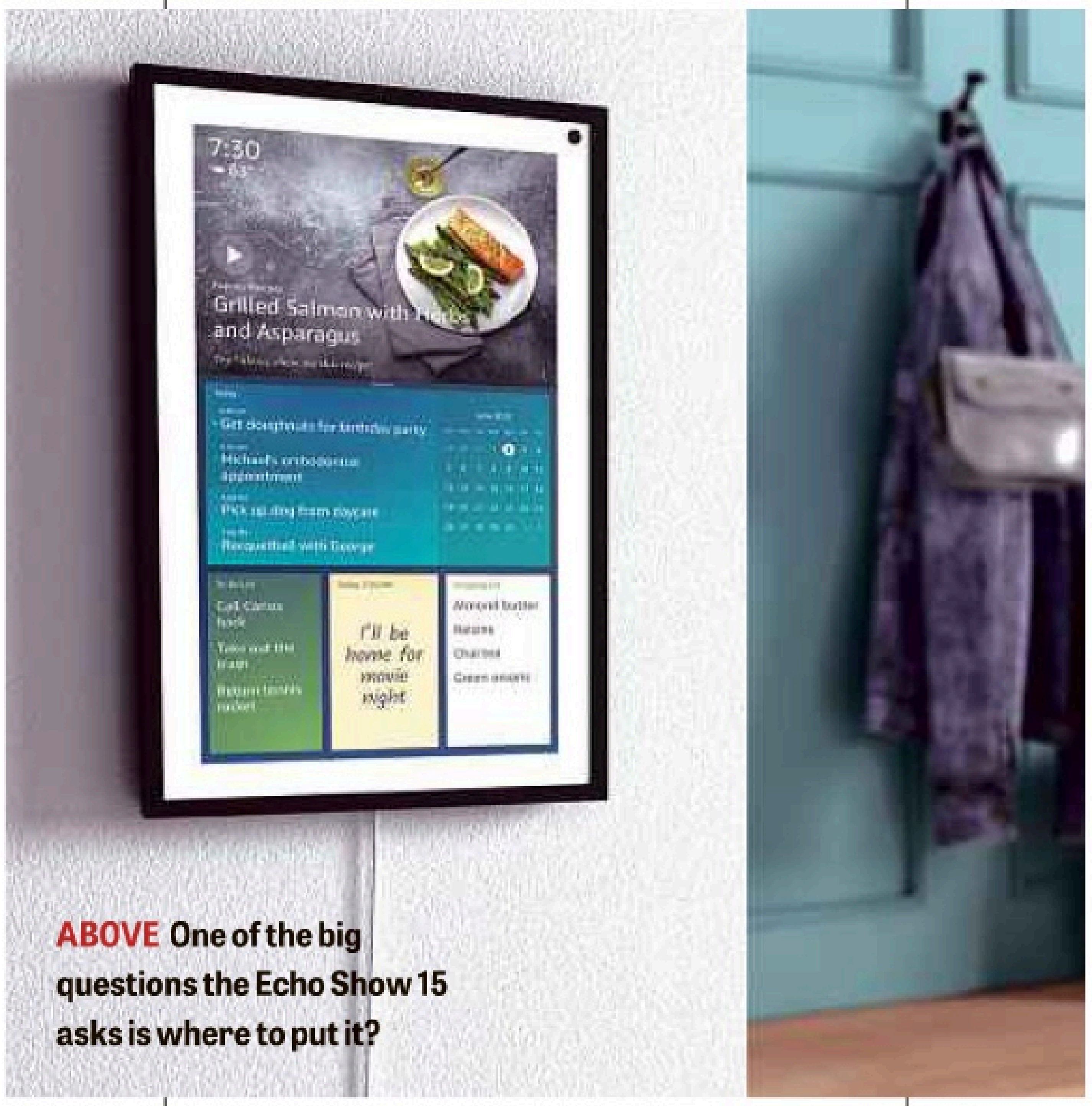
I also found it a pleasant way to enjoy Audible audiobooks, while the integration with Spotify is excellent. Once your account is linked, it will prioritise your Spotify playlists over Amazon Music, for instance. The full-screen Spotify app is also useful, with details of what's playing, cover art and other listening suggestions. Compare that to the BBC Sounds app, which shows a station logo and tells you what programme you're listening to. It doesn't even reveal the name of tracks playing on BBC 6 Music.

Extra talents

The Echo Show 15 has many more talents than video and audio playback. There's a 5-megapixel camera for making video calls (complete with a shutter, naturally, and you can switch the microphones off too), but it's limited to other people with Echo Show devices or those willing to load up the Alexa app.

There's much stronger integration with third-party smart home devices, making this an excellent hub to view camera feeds, activate lights and even control your heating and robot vacuum cleaner. If you've resisted smart-home technology before, the Echo Show 15 may even inspire you to kit out your home or office.

Amazon is also pushing the idea of a shared family calendar, with the ability to aggregate a bunch of individual calendars into one homogenised view. So, you can ask Alexa what's on for your family today, or view everyone's upcoming appointments in the calendar widget. You can also ask family members to sign up to Amazon's face-recognition technology, after which it will recognise who's looking at it and adjust what they see. Sensibly, Amazon has anticipated that this will include children and can ensure "age-appropriate content" appears on the screen when it recognises your kids.


ABOVE One of the big questions the Echo Show 15 asks is where to put it?

Faltering start

As you can tell, this isn't the defining product of the century. There are too many areas where it needs to improve, from third-party apps and the choice of widgets to the screen quality.

Should you buy this first iteration? That's a more difficult call, because I'm certain that version two will be much improved. However, even with the Echo Show 15's limitations, it's an interesting addition to a busy family home. **TIM DANTON**

SPECIFICATIONS

15.6in, 1,920 x 1,080 touchscreen ● dual 1.6in stereo speakers ● 5MP camera ● Wi-Fi 5 ● Bluetooth (A2DP and AVRCP) ● 402 x 35 x 252mm (WDH) ● 2.2kg ● 1yr limited warranty

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Adobe Premiere Elements 2022

Powerful new tools and handy social media options make video editing fun for novices and the experienced

SCORE ★★★★★

PRICE £72 (£86 inc VAT) **from adobe.com**

Adobe Premiere Elements 2022 does its best to simplify the often complicated process of editing videos. While professionals can spend years mastering the nuances and intricacies of powerful software such as Adobe Premiere Pro, many of us just want to create and share fun and meaningful snippets of our life and loved ones. Premiere Elements excels in this regard, thanks to an accessible interface, easy-to-use tools and cool creative styling.

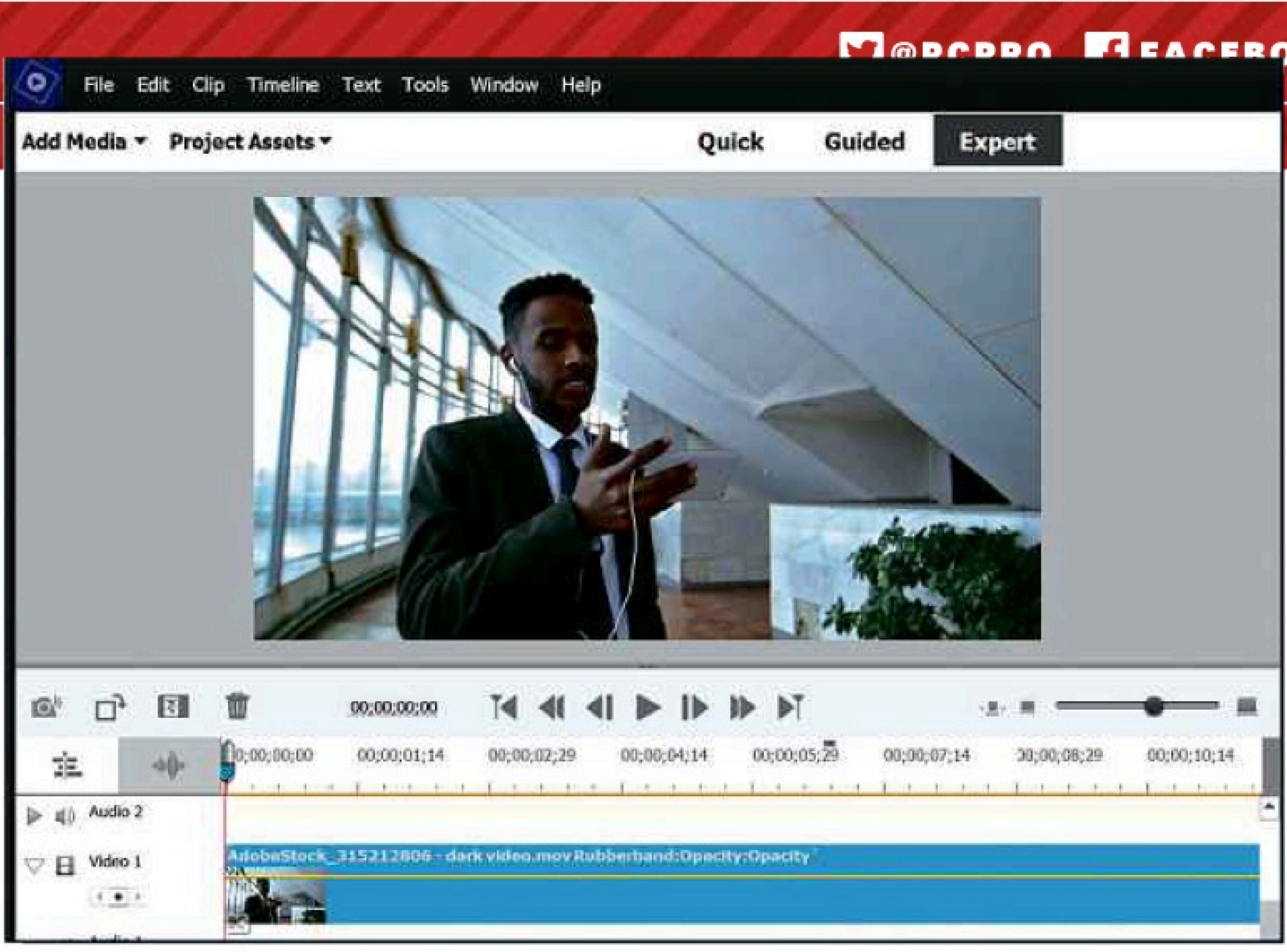
The three tabs on the interface – Quick, Guided and Expert – offer novices an opportunity to fix their videos quickly and learn more complex workflows, while providing more experienced users with plenty of sophisticated and powerful tools. This 2022 update adds a handful of improved features, and a couple of them are so useful that they will make family and hobby videographers smile with delight.

First up are social media features. Many videos created by consumers end up on social networks, and each network has a preferred aspect ratio for optimum viewing. Elements 2022 allows you to choose the aspect ratio of your project based on where you'll be uploading it to. Alternatively, you can export your video based on social media preset sizes, as well as presets for different devices such as a TV or a tablet. The one network that isn't among the setup or export options is Twitter. You must manually choose 1,280 x 720 (landscape or portrait) or 720 x 720.

When you choose to create or export a video in an aspect ratio other than the original, black borders will be automatically added to your video to avoid cropping the action. But you can choose to use the Adobe Sensei AI reframing tool to fill the frame with the central action of your video. The excess will then be cropped away.

For instance, say you want to create a vertical project from a horizontal clip. Sensei will analyse the clip and keep what it decides is the central action within the vertical crop. It sometimes cuts off important detail, because not every central action frame will fit into the chosen aspect ratio. That aside, Sensei AI reframing makes it easier to create smooth, attractive video projects that combine clips with different aspect ratios. Just bear in mind that it will work best if you shoot with a wide angle, leaving empty space around the central action.

When you open a vertical video in a new project, the project will now automatically set its aspect ratio to match the clip. In addition, in any vertical project, all assets – titles, mattes or backgrounds – will resize automatically when placed in the project. Given how many people hold their phones the wrong way when shooting videos, this new functionality is destined to be quite popular.


File Edit Clip Timeline Text Tools Window Help
Add Media
Project Assets
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Audio 2
Video 1
AdobeStock_315212806 - dark video.mov Rubberband:Opacity:Opacity

ABOVE Adobe's Guided Edits make it easier than ever to create fine videos

The Guided Edits feature in Premiere Elements 2022 helps users learn how to use key video-editing workflows. It's a simple setup that lets you work on your own videos in the Expert tab, with pop-ups guiding you. However, while generally great for helping you master what might initially seem complex processes, the Guided Edits often skimp on explanations.

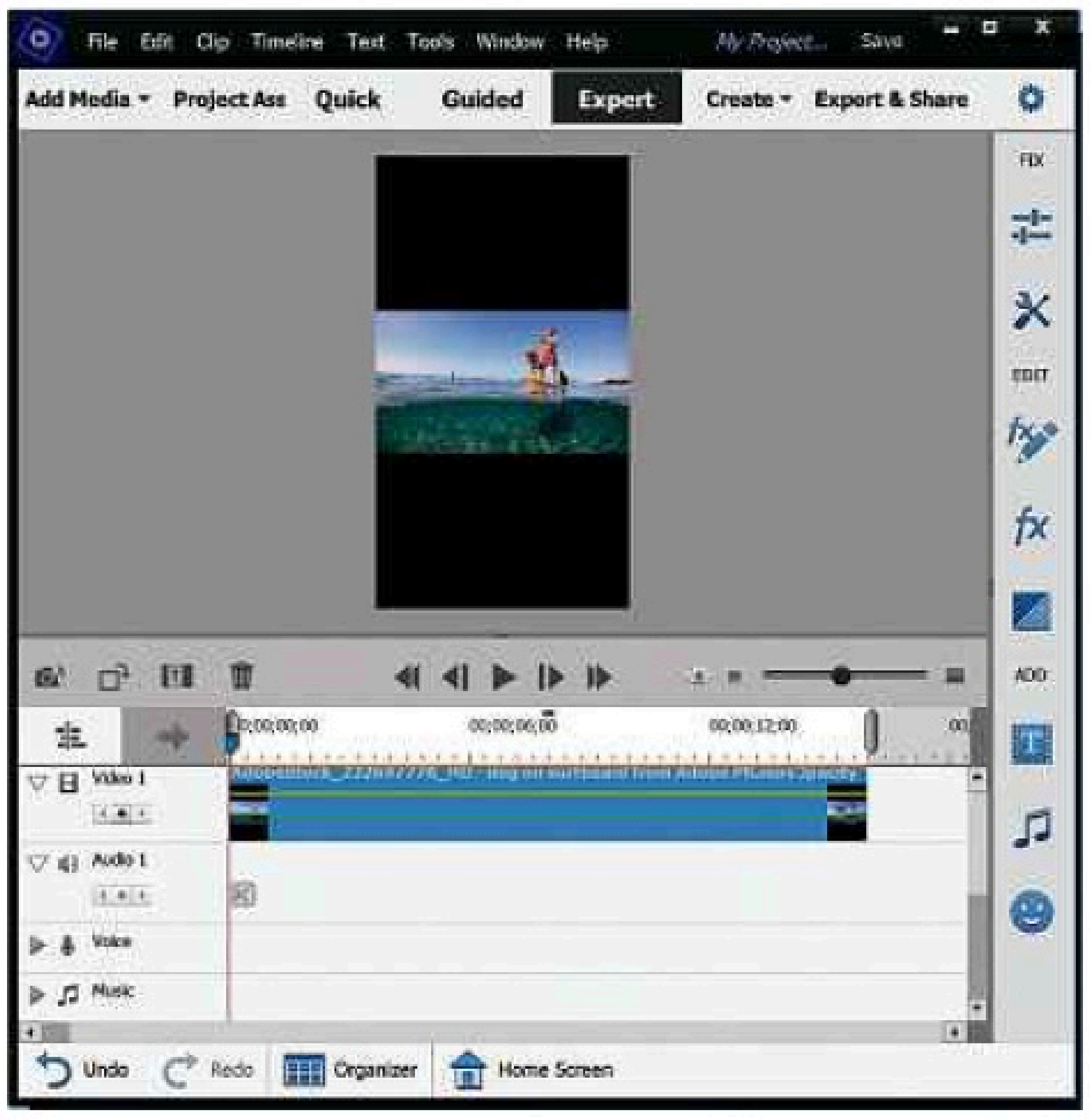
For instance, who doesn't have a video that captures one perfect moment, but that's either too dark or not sparkling enough? The new Adjust Shadows and Highlights Guided Edit gives step-by-step instructions to correct or improve a clip's exposure. It takes you from opening and placing the clip into the timeline, through using the Shadows and Highlights tool, then playing the video to check the effect and, finally, exporting it. However, it doesn't tell you how to edit your settings after you've applied them.

> **"Elements 2022 allows you to choose the aspect ratio of your project based on where you'll be uploading it to"**

The other new Guided Edit, Animated Overlays, is far less serious: it teaches you how to apply animated butterflies, bokeh lights, snowflakes, clouds and suchlike to your video. Options include Blend Modes, opacity, uniform or non-uniform scaling, rotation and an anti-flicker filter.

As ever, Premiere Elements isn't cheap, but at least the £86 Adobe charges is for a perpetual licence. You can also upgrade from a previous version for £71 or buy it as a bundle with Photoshop Elements 2022 for £130 (£107 for an upgrade).

Often, we say it isn't worth upgrading from last year's edition, but there's enough in this update to make it a worthwhile buy for a keen videographer. And if you're new to Premiere Elements, download the trial version and see if it's time to take the plunge. **SALLY WIENER GROTTA**


File Edit Clip Timeline Text Tools Window Help
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Add Media
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Create
Export & Share
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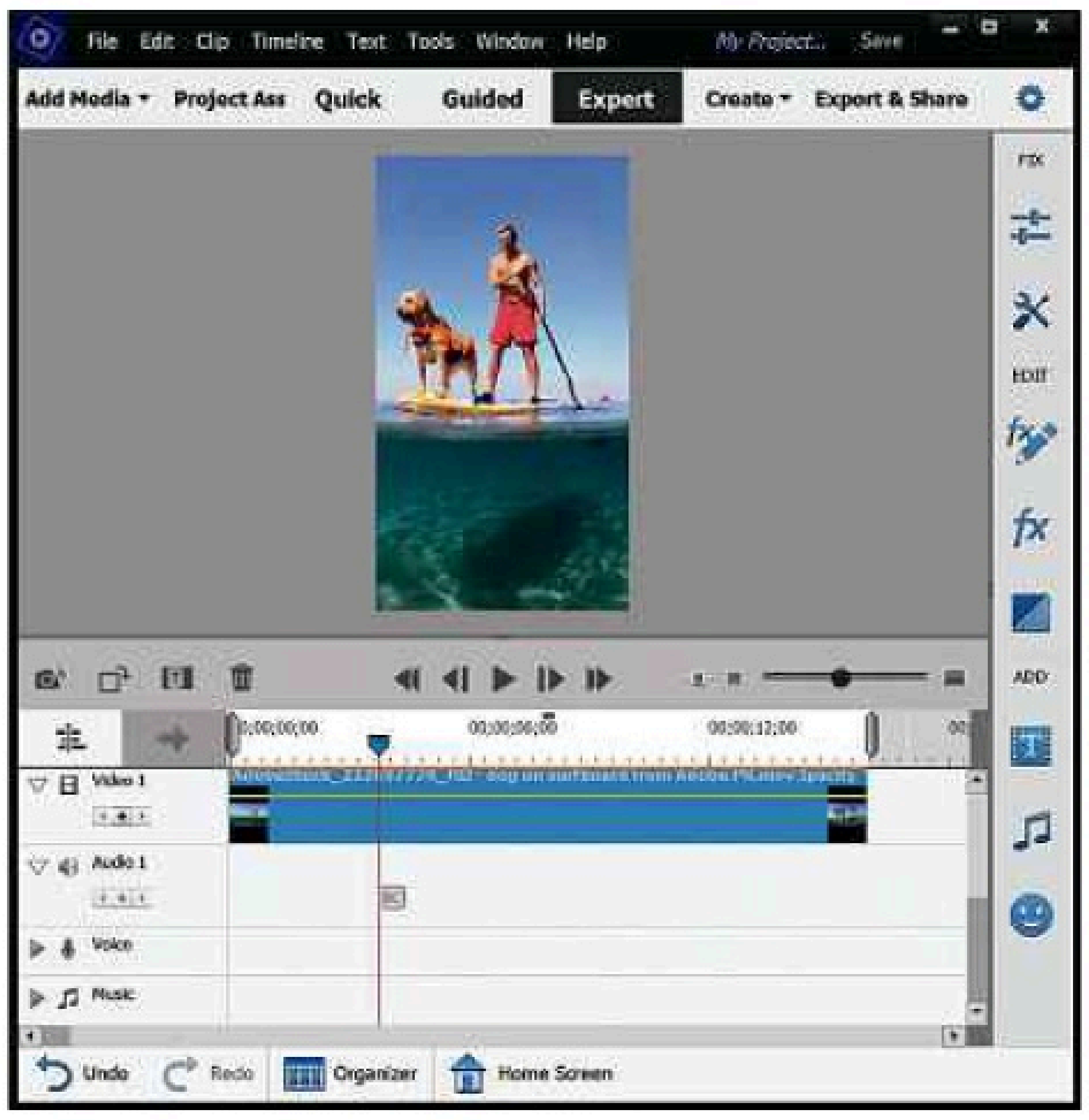
Audio 1
Voice
Music
Undo
Redo
Organizer
Home Screen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My Project... Save
Add Media
Project Ass
Quick
Guided
Expert
Create
Export & Share
Video 1
Audio 1
Voice
Music
Undo
Redo
Organizer
Home Screen

BELOW Convert horizontal videos to a social media-friendly vertical aspect ratio

REQUIREMENTS

8GB RAM ● 4GB graphics card VRAM ● Windows 10 version 2004 or newer ● macOS 10.15 or newer

ASUS | BUSINESS

PC
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RECOMMENDED

ASUS ExpertBook B1 (B1500)

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Windows 11

ASUS recommends Windows 11 Pro for business

Windows 11 brings you closer to what you love

* Specifications may vary by model and region

WINDOWS 11 LAPTOPS

THERE'S A BEWILDERING CHOICE OF LAPTOPS THAT ARE IDEAL FOR WINDOWS 11. WE TEST 15 VERY DIFFERENT MACHINES TO HELP YOU MAKE THE RIGHT CHOICE

If there's one thing this Labs shows, it's that the word "laptop" covers many forms. Over the next 20 pages you'll read about compact machines that you'll barely notice in a rucksack right through to monster gaming laptops that should come with free chiropractor vouchers.

Prices start at £349 but reach as high as £1,876, so it's fair to say that we have every budget covered. And don't think for a moment that spending more always buys you higher quality: there are a couple of real bargains among this month's group. And buyer beware when it comes to screen quality, with certain models including panels that made us sigh in despair.

In short, the unprepared buyer rocking up to a retailer – virtual or bricks-and-mortar – faces a bewildering array of choices. With budgets no doubt limited, there are also big questions to answer regarding where you spend your money.

By providing a snapshot of the form factors available, we hope this Labs guides you in the right direction. Here's hoping your ideal machine appears within.

CONTRIBUTOR: Tim Danton

BANG & OLUFSEN
intel
evo

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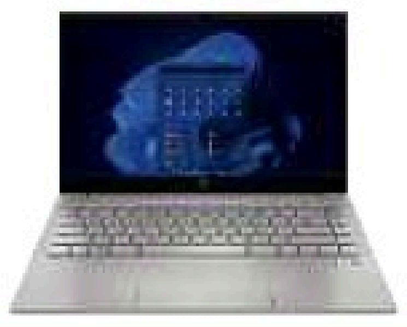
			RECOMMENDED	**RECOMMENDED**			**LABS WINNER**
	Acer Aspire 5 A514-54	**Acer Swift 3 SF314-43**	**Acer TravelMate P4 P414-51**	**Asus ExpertBook B1 B1500**	**Asus TUF Dash F15**	**Chillblast Fusion Iris**	**Dell XPS 13 9310 2-in-1**
Overall rating	★★★☆☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★☆☆	★★★★★
Purchase information							
Price of specific model tested [1]	£499 (£599 inc VAT)	£583 (£699 inc VAT)	£619 (£743 inc VAT)	£524 (£628 inc VAT)	£1,000 (£1,200 inc VAT)	£667 (£800 inc VAT)	£1,066 (£1,279 inc VAT)
Range starting price	£375 (£450 inc VAT)	£441 (£529 inc VAT)	£619 (£743 inc VAT)	£499 (£599 inc VAT)	£625 (£750 inc VAT)	£667 (£800 inc VAT)	£1,066 (£1,279 inc VAT)
Supplier	currys.co.uk	currys.co.uk	box.co.uk	uk.insight.com	box.co.uk	chillblast.com	dell.co.uk
Part code	NX.A68EK.002	NX.AB1EK.007	NX.VPCEK.001	B1500CEAE-BQ0782R	FX516PR-HN002	N/A	cn93101sc
Dimensions (WDH)	328 x 223 x 18mm	323 x 212 x 15.9mm	325 x 236 x 17.9mm	358 x 237 x 19.4mm	360 x 252 x 20mm	359 x 234 x 18mm	297 x 207 x 14.4mm
Weight	1.7kg	1.2kg	1.4kg	1.7kg	2kg	1.8kg	1.3kg
Service & support							
Warranty [2]	1yr RTB	1yr RTB	1yr RTB	1yr RTB	1yr RTB	2yr C&R	1yr on-site
Manufacturer support/ reliability score [3]	75%/86%	75%/86%	75%/86%	76%/87%	76%/87%	N/A	77%/83%
Core components							
Processor	Intel Core i5-1135G7	AMD Ryzen 5 5500U	Intel Core i5-1135G7	Intel Core i5-1135G7	Intel Core i7-11370H	Intel Core i7-1165G7	Intel Core i5-1135G7
Processor base speed (boost speed)	2.4GHz (4.2GHz)	2.1GHz (4GHz)	2.4GHz (4.2GHz)	2.4GHz (4.2GHz)	3.3GHz (4.8GHz)	2.8GHz (4.7GHz)	2.4GHz (4.2GHz)
Processor cores (threads)	4 (8)	6 (12)	4 (8)	4 (8)	4 (8)	4 (8)	4 (8)
RAM fitted (speed)	8GB DDR4 (2,666MHz)	8GB LPDDR4 (4,266MHz)	8GB DDR4 (3,200MHz)	8GB DDR4 (3,200MHz)	16GB DDR4 (3,200MHz)	16GB DDR4 (2,666MHz)	8GB LPDDR4 (4,266MHz)
Primary GPU	Intel Iris Xe	AMD Radeon Vega 7	Intel Iris Xe	Intel Iris Xe	8GB Nvidia GeForce RTX 3070 Mobile	Intel Iris Xe	Intel Iris Xe
Display							
Display size	14in	14in	14in	15.6in	15.6in	15.6in	13.4in
Resolution	1,920 x 1,080	1,920 x 1,080	1,920 x 1,080	1,920 x 1,080	1,920 x 1,080	1,920 x 1,080	1,920 x 1,200
Pixel density	157ppi	157ppi	157ppi	141ppi	141ppi	141ppi	169ppi
Frequency	60Hz	60Hz	60Hz	60Hz	144Hz	60Hz	60Hz
Touchscreen	✗	✗	✗	✗	✗	✗	✓
Glossy or matte?	Matte	Matte	Matte	Matte	Matte	Matte	Glossy
Storage							
Model	Kingston OM8PCP3512F-AA	Micron 2210	SK Hynix BC511	WDC SN530	SK Hynix BC711	Samsung SSD 980	Kioxia BG4
Type	M.2 NVMe	M.2 NVMe	M.2 NVMe	M.2 NVMe	M.2 NVMe	M.2 NVMe	M.2 NVMe
Capacity	512GB	1TB	256GB	256GB	512GB	500GB	256GB
Battery & charger							
Battery type (capacity)	48Wh	53Wh	55Wh	42Wh	76Wh	54Wh	51Wh
Charger wattage	65W	65W	65W	65W	200W	65W	45W
Charger weight [4]	344g	344g	295g	298g	628g	379g	247g
Charging claims	None	4hrs of use in 30mins	None	None	50% in 30mins	None	3hrs full charge
Charging options	DC (supplied)	DC (supplied), USB-C	DC (supplied), USB-C	DC (supplied), USB-C	DC (supplied), USB-C	DC (supplied)	USB-C (supplied)
Webcam							
Maximum video	720p, 30fps	720p, 30fps	1080p, 30fps	720p, 30fps	N/A	720p, 30fps	720p, 30fps
Photo resolution	1,280 x 720	1,280 x 720	1,920 x 1,080	1,280 x 720	N/A	1,280 x 720	1,280 x 720
Windows Hello?	✗	✗	✓	✗	✗	✗	✓
Ports & connectivity							
Wireless standard	Wi-Fi 6	Wi-Fi 6	Wi-Fi 6	Wi-Fi 6	Wi-Fi 6	Wi-Fi 6	Wi-Fi 6
Bluetooth	Bluetooth 5	Bluetooth 5	Bluetooth 5	Bluetooth 5.2	Bluetooth 5.1	Bluetooth 5.1	Bluetooth 5.1
Gigabit Ethernet	✓	✗	✓	✓	✓	✓	✗
HDMI	✓	✓	✓	✓	✓	✓	✗
USB-C/Thunderbolt	USB 3.2 Gen 1 (5Gbits/sec)	USB 3.2 Gen 2 (10Gbits/sec)	USB 3.2 Gen 2 (10Gbits/sec), Thunderbolt 4	Thunderbolt 4	Thunderbolt 4	USB 3.2 Gen 2 (10Gbits/sec)	2 x Thunderbolt 4
USB-A	2 x USB 3.2 Gen 1 (5Gbits/sec)	2 x USB 3.2 Gen 1 (5Gbits/sec)	2 x USB 3.2 Gen 2 (10Gbits/sec)	2 x USB 3.2 Gen 2 (10Gbits/sec), USB 2	3 x USB 3.2 Gen 1 (5Gbits/sec)	2 x USB 3.2 Gen 1 (5Gbits/sec), USB 2	Via adapter
MicroSD card reader	✗	✗	✓	✓	✗	✓	✓
Audio jack	✓	✓	✓	✓	✓	✓	✓
Other	✗	✗	Smart Card reader	D-SUB	✗	✗	✗
Other features							
Backlit keyboard (brightness levels)	✗	✓ (1)	✓ (1)	✓ (1)	✓ (2)	✓ (2)	✓ (2)
Touchpad dimensions (WH)	105 x 65mm	105 x 65mm	105 x 66mm	105 x 73mm	105 x 73mm	130 x 85mm	112 x 67mm
Fingerprint reader	✓	✓	✓	✓	✗	✗	✓
Other	✗	✗	✗	✗	✗	✗	McAfee LiveSafe (1yr)
Supplied OS	Windows 10 Home	Windows 10 Home	Windows 10 Pro	Windows 10 Pro	Windows 10 Home	Windows 11 Home	Windows 10 Home
Windows 11 status [5]	Waiting for update	Upgrade offered	Upgrade offered	Upgrade offered	Waiting for update	Supplied	Upgrade offered

[1] Mainland UK only. [2] Parts and labour, UK mainland, unless otherwise stated. [3] Laptop support/reliability rating in reader-voted *PC Pro* Excellence Awards 2021. Where N/A, companies didn't receive enough feedback to be rated. See issue 326, p26. [4] Includes all cables, not just the main unit. [5] Status was correct in early January 2022.

							
			RECOMMENDED		RECOMMENDED		
Geo GeoFlex 340	**HP EliteBook 840 Aero G8**	**HP Envy 14**	**HP Pavilion 14**	**Huawei MateBook 14s**	**MSI Pulse GL66**	**PCSpecialist Fusion Studio 14in**	**PCSpecialist Lafité Pro 17.3in**
★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆
£291 (£349 inc VAT)	£1,563 (£1,876 inc VAT)	£1,167 (£1,400 inc VAT)	£567 (£680 inc VAT)	£1,083 (£1,300 inc VAT)	£749 (£899 inc VAT)	£887 (£1,064 inc VAT)	£722 (£866 inc VAT)
£291 (£349 inc VAT)	£949 (£1,139 inc VAT)	£917 (£1,100 inc VAT)	£458 (£549 inc VAT)	£1,000 (£1,200 inc VAT)	£749 (£899 inc VAT)	£730 (£876 inc VAT)	£698 (£837 inc VAT)
very.co.uk	bechtle.com/gb	hp.com	hp.com	consumer.huawei.com/uk	scan.co.uk	pcspecialist.co.uk/reviews	pcspecialist.co.uk/reviews
5060704191867	3G2L8EA#ABU	30B00EA#ABU	2G2E2EA#ABU	HKD-W76	11UDK-249UK	N/A	N/A
322 x 218 x 16mm	323 x 215 x 17.9mm	313 x 224 x 17.9mm	325 x 212 x 17mm	314 x 230 x 16.7mm	359 x 259 x 24.4mm	308 x 213 x 17mm	395 x 252 x 19.8mm
1.3kg	1.2kg	1.6kg	1.4kg	1.4kg	2.1kg	1.1kg	2.3kg
2yr C&R	3yr RTB	1yr RTB	1yr RTB	1yr RTB	2yr RTB	3yr (1mth C&R, 1yr parts, 3yr labour)	3yr (1mth C&R, 1yr parts, 3yr labour)
N/A	73%/83%	73%/83%	73%/83%	N/A	N/A	N/A	N/A
Intel Core i3-10110U	Intel Core i5-1135G7	Intel Core i7-1165G7	Intel Core i5-1135G7	Intel Core i7-11370H	Intel Core i7-11800H	Intel Core i7-11370H	Intel Core i5-11300H
2.1GHz (4.2GHz)	2.4GHz (4.2GHz)	2.8GHz (4.7GHz)	2.4GHz (4.2GHz)	3.3GHz (4.8GHz)	2.3GHz (4.6GHz)	3.3GHz (4.8GHz)	3.3GHz (4.8GHz)
2 (4)	4 (8)	4 (8)	4 (8)	4 (8)	8 (16)	4 (8)	4 (8)
4GB DDR4 (2,666MHz)	16GB DDR4 (3,200MHz)	16GB DDR4 (3,200MHz)	8GB DDR4 (3,200MHz)	16GB LPDDR4 (3,733MHz)	16GB DDR4 (3,200MHz)	8GB DDR4 (2,666MHz)	8GB DDR4 (2,666MHz)
Intel UHD Graphics	Intel Iris Xe	4GB Nvidia GeForce GTX 1650 Ti with Max-Q design	Intel Iris Xe	Intel Iris Xe	4GB Nvidia GeForce RTX 3050 Ti Mobile	Intel Iris Xe	Intel Iris Xe
14.1in	14in	14in	14in	14.2in	15.6in	14in	17.3in
1,920 x 1,080	1,920 x 1,200	1,920 x 1,200	1,920 x 1,080	2,520 x 1,680	1,920 x 1,080	2,880 x 1,800	1,920 x 1,080
156ppi	162ppi	162ppi	157ppi	213ppi	141ppi	243ppi	127ppi
60Hz	60Hz	60Hz	60Hz	90Hz	144Hz	90Hz	60Hz
✓	✗	✓	✓	✓	✗	✗	✗
Glossy	Matte	Glossy	Matte	Glossy	Matte	Matte	Matte
Netac SSD	Micron 2210	Samsung MZVLB1T0HBLR	WDC SN530	Unbranded	Kingston 500C	PCS	Intel 670p
SATA 2.5in	M.2 NVMe	M.2 NVMe	M.2 NVMe	M.2 NVMe	M.2 NVMe	M.2 NVMe	M.2 NVMe
128GB	512GB	1TB	256GB	1TB	512GB	1TB	512GB
44Wh	53Wh	63Wh	40Wh	59Wh	52Wh	53Wh	73Wh
40W	65W	135W	45W	90W	150W	90W	65W
283g	311g	455g	290g	243g	488g	515g	337g
None	50% in 30mins	50% in 30 minutes	50% in 45 minutes	3hrs on 15mins charge	None	None	None
DC (supplied)	DC, USB-C (supplied)	DC (supplied), USB-C	DC (supplied), USB-C	USB-C (supplied)	DC (supplied)	DC (supplied)	DC (supplied)
720p, 30fps	720p, 30fps	720p, 30fps	720p, 30fps	720p, 30fps	720p, 30fps	720p, 30fps	720p, 30fps
1,280 x 720	1,280 x 720	1,280 x 720	1,280 x 720	1,280 x 720	1,280 x 720	1,280 x 720	1,280 x 720
✗	✓	✗	✗	✓	✗	✓	✓
Wi-Fi 5	Wi-Fi 6	Wi-Fi 6	Wi-Fi 5	Wi-Fi 6	Wi-Fi 6	Wi-Fi 6	Wi-Fi 6
Bluetooth 4.2	Bluetooth 5.2	Bluetooth 5.2	Bluetooth 5.1	Bluetooth 5.1	Bluetooth 5.2	Bluetooth 5.2	Bluetooth 5.2
✗	✗	✗	✗	✗	✓	✗	✓
✗	✓	✓	✓	✓	✓	✓	✓
USB 3.2 Gen 1 (5Gbits/sec)	2 x USB 4/Thunderbolt 4	USB 4/Thunderbolt 4	USB 3.2 Gen 2 (10Gbits/sec)	USB-C 3.2 Gen 2 (10Gbits/sec), Thunderbolt 4 (Space Grey version only)	USB 3.2 Gen 1 (5Gbits/sec)	Thunderbolt 4, USB 3.2 Gen 2 (10Gbits/sec)	Thunderbolt 4, USB 3.2 Gen 2 (10Gbits/sec)
USB 3.2 Gen 1 (5Gbits/sec)	2 x USB 3.2 Gen 1 (5Gbits/sec)	2 x USB 3.2 Gen 1 (5Gbits/sec)	2 x USB 3.2 Gen 1 (5Gbits/sec)	USB 3.2 Gen 1 (5Gbits/sec)	2 x USB 3.2 Gen 1 (5Gbits/sec), USB 2	2 x USB 3.2 Gen 1 (5Gbits/sec)	USB 3.2 Gen 1 (5Gbits/sec), USB 2
✓	✓	✓	✓	✗	✗	✗	✓
✓	✓	✓	✓	✓	✓	✓	✓
M.2 expansion port	✗	✗	✗	✗	✗	SD card reader (full size)	✗
✗	✓ (2)	✓ (2)	✗	✓ (2)	✓ (1)	✓ (2)	✓ (4)
114 x 72mm	110 x 61mm	115 x 73mm	115 x 73mm	120 x 72mm	105 x 65mm	131 x 81mm	151 x 91mm
✗	✓	✓	✓	✓	✗	✗	✗
✗	HP Wolf Pro Security Edition (3yr licence)	✗	✗	Free gifts on purchase	✗	✗	✗
Windows 11 Home	Windows 10 Pro	Windows 10 Home	Windows 10 Home	Windows 10 Home	Windows 10 Home	Windows 11 Home	Windows 11 Home
Supplied	Upgrade offered	Waiting for update	Upgrade offered	Waiting for update	Waiting for update	Supplied	Supplied

Buyer's guide: 13 questions you need to ask

Before investing hundreds of pounds in a laptop, there are some important questions you need to ask yourself

When will I get Windows 11?

One of our criteria for this group test is self-evident: the laptop must be capable of running Windows 11. Ideally, we wanted the laptops to ship with Windows 11, but those models sold at retailers will ship with Windows 10 for a while. Luckily, they should soon update themselves (with your consent) to Windows 11 via Windows Update. Check out the bottom row of our feature table on p76 to see each model's status at a glance; where we were offered an update during the test, we say "Upgrade offered". Where we were still waiting at the end of the test, we put "Waiting for update". We also indicate if a laptop was supplied with Windows 11.

How good is the webcam?

Two years ago, the quality of webcams was rarely discussed. Now they're of keen importance to anyone forced to work at home, but unfortunately laptop makers haven't responded as quickly as we'd like to the shift in priorities. At best, the webcams here are passable and no more.

How do I choose the right processor?

We were surprised to see only one laptop with an AMD Ryzen chip inside. Providing you choose a machine with a Ryzen 4000 or Ryzen 5000 series processor then we think you'll be pleased with both the performance and battery life. Some Ryzen chips also include more cores than Intel machines, which can slash the time taken to perform tasks that take advantage of multiple threads, such as video encoding.

However, Intel still rules this month's court via its 11th generation Core processors. These are denoted by "11" at the start of their names, such as the Core i7-1135G7 in the Acer Aspire 5. Look out for a "G5" or "G7" at the end, as this denotes an integrated Iris Xe graphics chip. Compared to the Intel Ultra HD graphics in older Core processors, this offers a big boost in games.

ABOVE If you're constantly on the move, look for a laptop weighing 1.3kg or less

What about gaming?

If you want a gaming system, then you need a discrete graphics chip. Nvidia is your friend here, with its GTX and RTX families making a total of three appearances among this month's group. The GTX 1650 Ti in the HP Envy is still a fine choice for modest games such as *Fortnite*, and will also allow you to up the settings in older first-person shooters. For those with more demanding titles in mind, an RTX 3050 or RTX 3060 offers a route to high frame rates at 1080p.

We were surprised to see only one laptop with an AMD Ryzen chip inside. Intel still rules via its 11th generation Core processors

Most gaming laptops include screens with higher refresh rates, too. Where laptops include discrete graphics, we cover these screens' abilities in the reviews, along with the machines' performance in demanding games such as *Metro: Exodus* and *Shadow of the Tomb Raider*.

BELOW Make sure your chosen laptop has all the ports you need

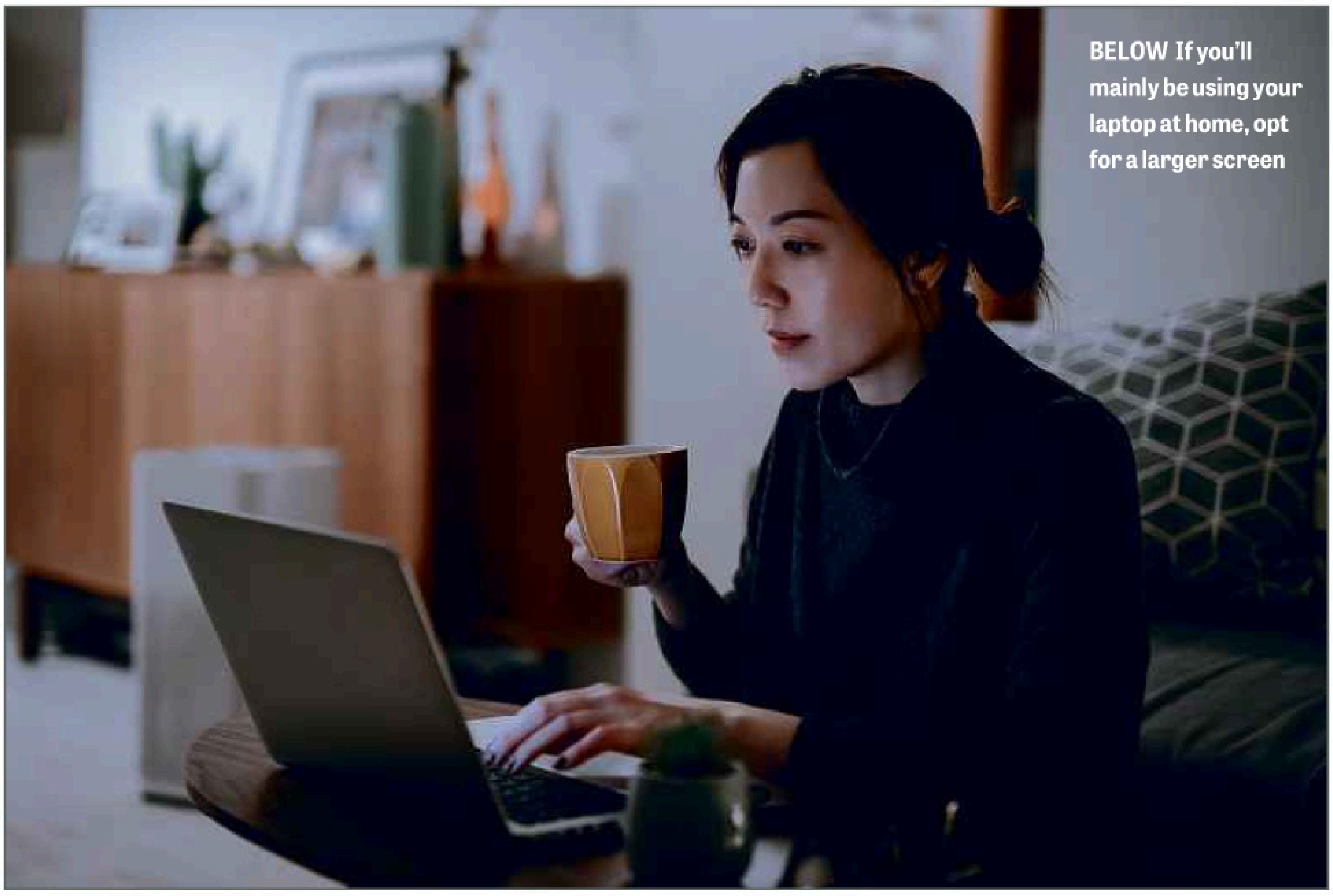
How much memory (RAM) do I need?

While Windows 11 will happily run with 4GB of RAM – as shown by the Geo GeoFlex – we recommend 8GB if you can afford it. Only those who use demanding applications will need 16GB or 32GB of RAM, but it's nice to have the headroom. Note that few laptops include a way to upgrade the RAM, with the memory often soldered onto the motherboard and no available slots for adding more.

How important is portability to me?

If you're constantly on the move – a student going to lectures or a worker who will one day return to the office commute, perhaps – then it's worth choosing a laptop weighing 1.3kg or less. These also tend to be slimmer, so are easier to slip into a bag. Also take note of the battery life, as this will dictate whether you need to bung the charger in the bag, too; many lightweight laptops include USB-C chargers, and we include their weights in the feature table on p76.

If your laptop is going to spend most of its life on a desk, then there's not much point worrying about weight. Anything under 2kg is fine, but as laptops approach this weight



BELOW If you'll mainly be using your laptop at home, opt for a larger screen

you won't want to lug it about the house every hour. If you know you'll be moving from room to room, then try not to go over 1.5kg. However, there is one more related question you need to answer…

What about screen size?

The yin to portability's yang, screen size is one of the biggest decisions you need to make. If this is going to be your daily machine, then you may find a 13in screen a fraction too small; 14in screens are that much more comfortable to use, and by comparison 15.6in screens can seem absolutely enormous.

However, if you're using a laptop for daily work at home, we strongly recommend that you partner it with a separate monitor. Ideally, you should choose a monitor with a USB-C connection and a laptop that can charge via USB-C (again, we list this in the feature table), as this will make your desk that much neater.

While you're at it, mouse and keyboard sets are cheap and make a huge difference to posture.

Do I need a touchscreen – or even a 2-in-1?

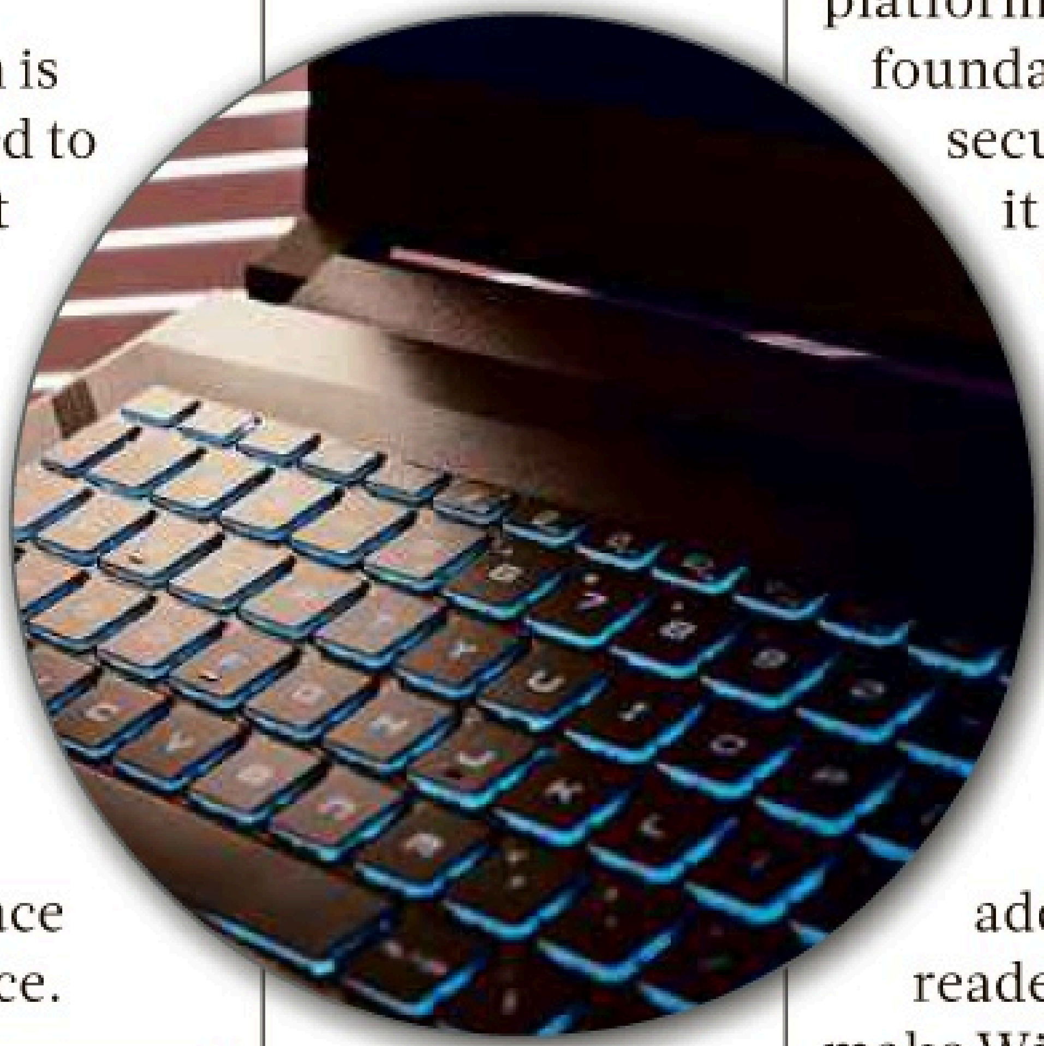
Few people need a touchscreen on their laptop: it's only a vital inclusion if you want to draw or write on the surface. It's also one more thing to go wrong, and should the screen break it can be expensive to fix.

All that said, a touchscreen is nice to have. Once you get used to a touchscreen laptop you start instinctively using it to prod windows and swipe along, just like using a phone. And if you choose a 2-in-1 design such as the Dell XPS 13 2-in-1 on p82, it adds a whole new dimension to your laptop: you can put it into tent mode for watching films, and use the screen surface as a notepad or drawing surface.

How much storage do I need?

Thankfully, the days of 128GB SSDs appear to be nearing their end: only one machine here includes such a drive (the Geo again), and it offers easy expansion. Drives with 256GB are the norm and fine for most people. The jump from 256GB to 512GB gives welcome space, but will pay particular dividends if you know you'll be downloading games or handling large media files.

If you're using a laptop for daily work at home, we strongly recommend that you partner it with a separate monitor



ABOVE Backlit keyboards are useful in dark environments

What about security?

All these machines include a trusted platform module (TPM), as this is the foundation of many of Windows 11's security features. For example, it's a key part in Windows Hello facial recognition, where suitably equipped laptops lock the machine unless they recognise you. It's also used in BitLocker encryption, which you can enable for the whole disk or for certain folders.

As well as providing additional security, fingerprint readers and facial recognition both make Windows 11 more convenient as they remove the need for entering a password or PIN every time you switch on your machine.

What ports do I need?

Every single laptop here includes at least one USB-C port, but while these look identical they vary in their capabilities. Ideally you want a port that allows you to charge the laptop, connect to a monitor and speedily transfer data. We list their transfer rates in the feature table.

It's also useful to have at least one USB-A port (a traditional USB port), as that makes it easier to connect flash drives, printers and countless other peripherals. HDMI ports are also useful for similar reasons: if your monitor doesn't support USB-C, then that's the next best way to connect.

What about extras?

Then there are the extras. For example, a backlit keyboard is unnecessary in well-lit environments, but a huge boon in darker conditions such as on a plane. Most people can also live without microSD card slots. But both these features (and others we mention in the reviews) are convenient at times.

Do chargers matter?

It seems a minor point, but we far prefer it when manufacturers (such as Huawei) supply compact USB-C chargers compared to the traditional "rat and tail" power supplies. The latter are cumbersome and heavy by comparison. Also look out for the power rating: as a rule of thumb, the higher the wattage, the quicker battery will recharge.

Finally, take a good look at the connectivity on offer. Some laptops offer USB-C connectors alone, which could be a pain if you still rely on USB-A peripherals (as a rule, we still like to have one USB-A port, just in case). However, buying a USB-C docking monitor or a port replicator will solve that problem at a desk.

➔

Reviewing ranges versus individual laptops

Reviewing laptops is fraught with difficulty, particularly ones made by the likes of Acer and HP. The biggest challenge is that particular configurations we review often sell out quickly, and they're replaced with very slightly updated models, with a different size of SSD or a faster processor, for example.

This is why we try to review a "line" rather than an individual configuration. For example, there are several varieties of the Acer Aspire 5 A514-54, and they all use the same mix of chassis, screen, battery and keyboard. You can then choose the processor and storage capacity that best meet your needs.

Acer TravelMate P4 P414-51

A great-value business laptop that has quality where you need it, and is well suited to life on the road

SCORE ★★★★☆

PRICE £619 (£743 inc VAT)
from box.co.uk

ABOVE Solid stuff: the TravelMate P4 exudes reassuring sturdiness

If we were forced to summarise the Acer TravelMate P4 P414-51 in one word, it would be “solid”. This isn’t a laptop that will bring an admiring glance from passers-by, nor one that will ever sit at the top of the performance charts, but if you’re after a business laptop for an aggressive price then it deserves to be at the top of your shortlist.

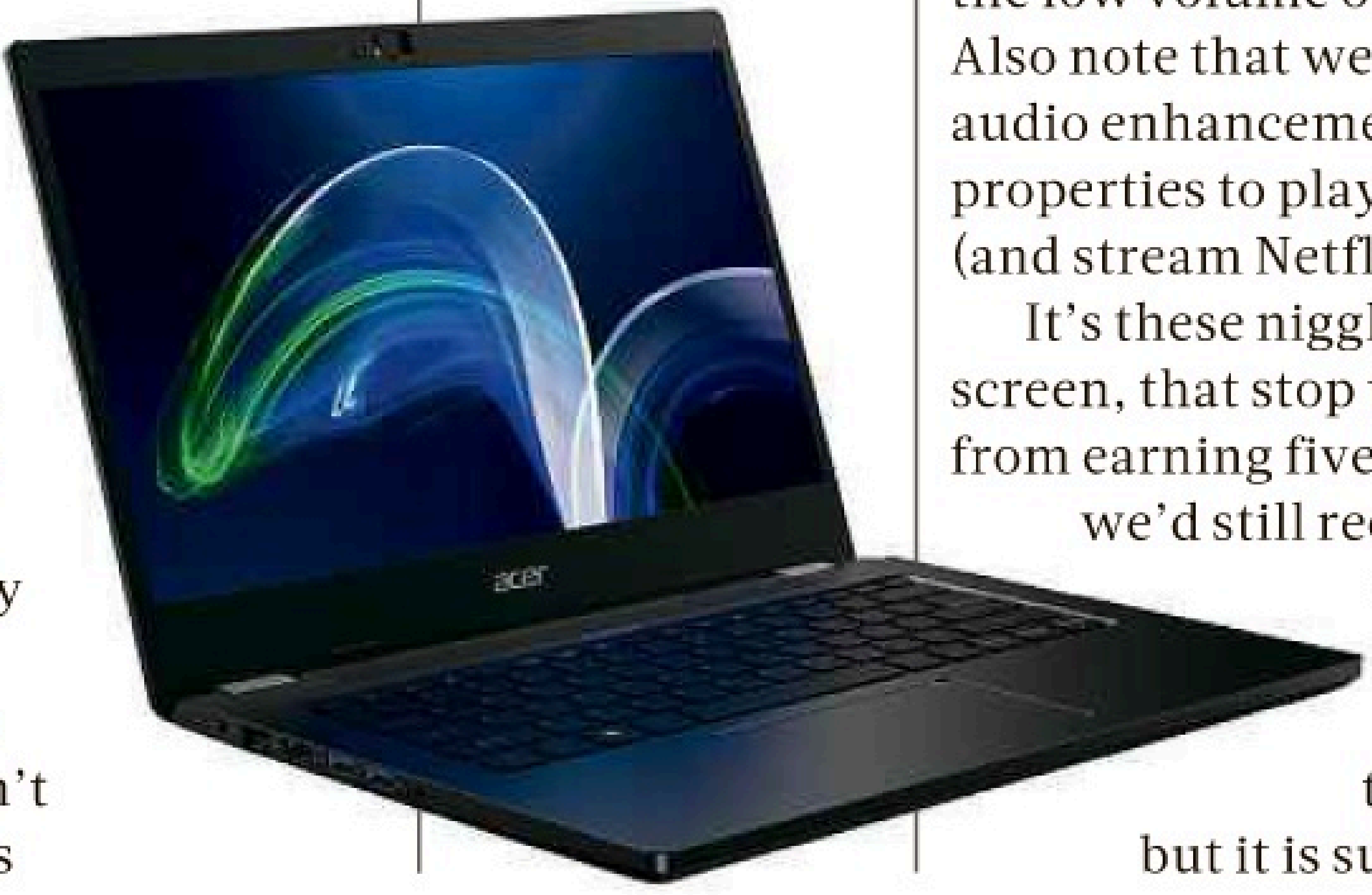
In part that’s due to the solidity of the laptop. Other machines at this price often feel thrown together, but the TravelMate P4 exudes reassuring sturdiness. That’s despite the fact only the lid is made from metal, with the rest of the chassis fashioned from rigid plastic, and its dark blue livery gives it a professional look. Windows 10 Pro comes as part of the package – we were offered an upgrade to Windows 11 Pro within a week of use – and our only criticism is that Acer doesn’t upgrade its warranty to two years as standard.

LEFT The 1.4kg weight and compact footprint make it easy to carry

There are some handy security features built in, too, with support for Windows Hello via the IR webcam and the fingerprint reader embedded into the power button. The former works seamlessly, but with the power button awkwardly placed on the right edge of the chassis, this proved more of a faff in practice. Acer also provides a Smart Card reader on the front edge, with a microSD card reader on the right, but it’s the left-hand side that holds most of the physical ports: two USB-A, Gigabit Ethernet, HDMI and a solitary USB-C port. The latter supports Thunderbolt 4, with both Type-A connectors supporting USB 3.2 Gen 2 for fast 10Gbits/sec transfer speeds.

Acer supplies a 65W DC power brick, but you can charge this laptop via the USB-C port as well. A 55Wh battery isn’t the largest, but you can still expect around nine hours of life from a charge – yet another solid result. This means you should get away with taking the TravelMate into town without bunging the charger into your bag, and with a 1.4kg weight and compact footprint this laptop lives up to its name.

It’s also a solid performer, with our unit – identified by its part number NX.VPCEK.001 – powered by a Core i5-1135G7. Other laptop manufacturers squeeze more out of this chip than Acer, as is shown by the graphs on p92, where it’s soundly beaten by the Asus ExpertBook and Dell XPS 13 2-in-1 in most tests. But for general office tasks we doubt you’d notice any difference between the machines. You can also add to the 8GB of RAM (as well as replace the SSD and, more trickily, the battery) by removing the dozen crosshead screws that secure the base; we recommend an electric screwdriver, as three of those 12 were devils to remove.



BELOW The screen is not the best we’ve seen for colour accuracy

Aside from this, the laptop is a pleasure to use. With the fan rarely brought to bear, it’s a largely silent machine and, so long as you don’t bash it, the keyboard is similarly quiet. There isn’t much travel or feel to the keys, but Acer covers the basics by including a (very bright) backlight and, for the most part, a sensible layout. The Enter key is huge, even if it’s annoying to have the Pg Up and Pg Dn immediately above the cursor keys. Acer would have been wise to include a larger trackpad to more easily accommodate gestures, but it works fine.

Considering this laptop’s price, we can’t complain about the screen, either. It covers 56% of the sRGB gamut and a mere 41% of DCI-P3, but whites are clean, it hit a satisfactory peak brightness of $306cd/m^2$ and its 1,558:1 contrast ratio is exceptional. It’s best not to linger on its colour accuracy scores – an average Delta E of 4.73 is poor – but this isn’t a laptop that will be used by videographers grading their work. Or at least, we hope not.

The speakers are clear if not exactly rich; good enough for watching the occasional film, speech radio and video calls. Acer annoyingly provides a mediocre 720p webcam, but the biggest hurdle to our calls was the low volume of the microphone. Also note that we had to switch off the audio enhancements in the speakers’ properties to play video recordings (and stream Netflix).

It’s these niggles, and the average screen, that stop the TravelMate P4 from earning five stars. However, we’d still recommend this Core i5 version for business buyers on a budget. It isn’t the perfect system, but it is superb value.

Asus ExpertBook B1 B1500

This is a fine choice for smaller companies that seek bigger screens, especially if money is tight

SCORE ★★★★☆

PRICE £524 (£628 inc VAT) from uk.insight.com

ABOVE The Acer ExpertBook B1 is a fine lightweight desktop replacement

As the saying used to go, an IT manager was never going to be fired for buying IBM. Today, in the world of laptops at least, that might equally be said of Dell, Dynabook (formerly Toshiba), HP and Lenovo, but as this Labs demonstrates both Acer and Asus now have compelling business offerings that deserve your attention.

In the case of the ExpertBook B1 series, its big appeal is value for money. At a fraction over £600, Asus is offering a well-balanced specification in a well-built chassis with a well-rounded supporting cast of security, screen and expansion offerings. At the risk of over-egging our point, it's great for the money.

The same could be said of the Acer TravelMate P4 opposite, but the ExpertBook targets a different type of user: one who's looking for a lightweight desktop replacement rather than a commuting machine. At 1.7kg you will notice it in a briefcase, and the chassis is wide at 358mm. However, it's also slim, and the fact it can be charged over USB-C as well as via the supplied (and relatively compact) DC power supply compensates for a lowly battery life of around six hours in our light-usage tests. Let's not gloss over those results: we hoped for eight hours, and the HP EliteBook whips it here with almost twice the battery life. As we say, this Asus is not designed for the daily commute.

LEFT The metal lid helps give the laptop a professional feel

All three business-focused laptops proved much closer in our speed tests, which shouldn't be a surprise as they all use Intel's Core i5-1135G7 processor. The HP's 16GB of RAM proved little advantage in our benchmarks, which reinforces our belief that there's little point in adding to the 8GB that Acer and Asus choose to accompany the mid-range CPU. These are machines designed for lightweight office tasks, not to tear through tough jobs that require as many cores as you can throw at them.

Still, there is room for expansion should you feel the need. Ten easy-to-remove crosshead screws are all that stand in your way; you then use a plastic slider to dislodge the ExpertBook's base and you're inside, where you'll find a single empty SODIMM socket (the supplied RAM is soldered on) and an occupied M.2 slot. There's also an empty 2.5in bay, making it simplicity itself to expand upon the supplied 256GB. You can also replace the battery, but that's more of a hassle.

Considering the aggressive price, we're happy with Asus' choice of screen. A peak brightness of 306cd/m^2 is fine for office use, and while 56% coverage of the sRGB gamut means it looks drab compared next to the best laptops this month (and an average Delta E of 4.54 certainly rules it out for anyone seeking colour accuracy), it's pleasant to look at. Generous viewing angles and a 6614K temperature – close to the perfect-whites target of 6500K – both help on that front.

Then we come to the keyboard, which would be at home on a laptop costing twice as much. The keys are well separated and easy to hit, with a quiet action that won't wear on you. Asus also separates out the cursor keys and finds room for a slim numberpad to the right. The trackpad could be larger, but that's our only complaint. It also helps that the speedy and effective fingerprint reader doubles as the power button.

Another nice touch is the privacy slider integrated into the 720p webcam. Sadly this is the highlight of the webcam, which suffers from a slight lag and mushy detail, though it captures audio well. The camera isn't compatible with Windows Hello, so there's no facial recognition to log you into Windows 11.

We were pleased to see an upgrade to Windows 11 was offered when we booted up the ExpertBook, and that Asus includes Pro rather than Home; it could have skimped on this at such a low price. It all adds up to the feeling that, webcam aside, you're getting far more than you have any right to expect for the price. While the chassis is made from plastic rather than metal (other than the lid), it looks the part of an executive's machine, too.

As with Acer and its TravelMate P4, the Asus ExpertBook proves there are business bargains to be had if you're willing to look outside the usual corporate suspects. You won't be fired for buying one.

BELOW The slim chassis offers plenty of room for expansion

Dell XPS 13 9310 2-in-1

Quality bursts from this gorgeous convertible, and it's easy to negotiate a chunk off the list price

SCORE ★★★★★

PRICE £1,066 (£1,279 inc VAT) from dell.co.uk

ABOVE The 13.4in screen offers more pixels than standard 1,920 x 1,080 panels

PC PRO LABS WINNER

As its name makes clear, this isn't a run-of-the-mill laptop: it's a 2-in-1 convertible, capable of transforming from laptop to tablet with one smooth swing of the hinge. As with every aspect of the XPS 13's engineering, it does so with grace and finesse; you can only compare Dell's 2-in-1 to the GeoFlex 340 in the same way that you can describe both Liverpool FC and Accrington Stanley as football teams.

The bigger question is whether a convertible design makes sense for you over the non-convertible XPS 13 or a rival such as the HP Pavilion 14. It certainly opens up your options. For instance, flip this laptop into tent mode and it becomes a superb mini TV. Or perhaps you need to read and sign a PDF. Here, tablet mode makes most sense.

Then there's the traditional laptop format, where the keyboard comes to the fore. Dell stretches the keys across almost the full width of the chassis, ensuring they're large and easy to hit. To add some extra class, a two-level backlight shines through the keys rather than around them, and the glass-coated trackpad is super-smooth. There is little travel to the action, however, which is one area where the standard XPS 13 is superior.

LEFT Flip the laptop into tent mode and it's ideal for watching TV

Dell integrates an effective fingerprint printer into the power button, just above the Backspace key, but you'll probably use the infrared webcam more frequently. Again, this works excellently, but we were less impressed by the quality of the webcam itself: noise-heavy images fail to bring out any detail.

We have fewer criticisms of the 13.4in screen, which offers 120 more vertical pixels than standard 1,920 x 1,080 panels to produce a 16:10 aspect ratio rather than 16:9. This also makes the panel a fraction sharper.

The screen holds a couple of potential irritations. The first is its glossy finish, although anti-glare technology reduces reflections of overhead lights. The second is that it isn't a perfect 6500K colour temperature; we measured 6365K, which lent whites a subtle warm hue.

Other than this, it's a tough display to criticise. It covers 96% of the sRGB gamut with an average Delta E of 0.57 (less than one is basically perfect), with a peak brightness of 564cd/m^2 and a superb contrast ratio of 1,825:1. Even though it isn't tuned to the DCI-P3 space favoured by Netflix and its ilk, covering 70% of that colour gamut, we enjoyed watching films on it. It helps that the speakers are among the best you'll find on a laptop.

What truly impresses, however, is the balance between power and longevity. Despite the aluminium alloy chassis measuring just 14.4mm, minimising opportunities for cooling, Dell makes good use of Intel's Core i5-1135G7 processor in both standard tasks and gaming. This laptop was one of the best performers in all our gaming tests, with a 50fps average in *Metro: Last Light* at 1080p. That's a superb result for a laptop with integrated graphics.

BELOW The large keys stretch across the width of the chassis

Then consider its results in our battery life tests, where it kept going for around 11 hours in our office and video playback scenarios. At 1.3kg, it's a brilliant choice for people on the move. The sole sacrifice you make is physical connectivity, with one USB-C port on either side (both output to monitors and support power delivery) along with a 3.5mm jack and microSD card slot. The lack of a USB-A port is potentially irritating, despite Dell providing a USB-C to USB-A travel adapter.

A final word on price. Dell often offers flash sales on its website, and we saw this specification (part code cn93101sc) for £1,049 at one point during our tests. This rose to £1,279 soon afterwards, but it's always worth asking the online assistants for savings. We chatted to Georgina and she offered a price of £1,100.

Note that the memory and SSD are both integrated onto the system board, so there's no way to upgrade yourself (Dell provides an excellent service manual for repairs, such as replacing the screen). If you want a 512GB SSD then your only option is to double the RAM to 16GB, upgrade to a Core i7 and switch to a 3,840 x 2,400 display. All of this pushes the list price to £1,829.

As such, our five-star rating is on the assumption you're happy with the lower spec and can persuade Georgina or her colleagues to sell you the Dell XPS 13 2-in-1 for £1,100 rather than £1,279. At that lower price, it's a superb buy.

Geo GeoFlex 340

Not top-drawer quality, but it's impossible to argue with its value – and the screen is a knockout for the price

SCORE ★★★★☆

PRICE £291 (£349 inc VAT) from very.co.uk

ABOVE The bright, colour-accurate display is a highlight

The GeoFlex is arguably the most interesting laptop in this Labs. Its most obvious standout feature in this company is its price, yet it still packs the handy ability to twist the screen round 360° to create a quasi tablet. So it's matching the Dell XPS 13 2-in-1 for features at a quarter of the price.

You might expect every other aspect of this machine to be sacrificed in the quest for low cost, but even here the GeoFlex 340 includes some surprises. Top of the list is its screen. Unlike the drab displays of some low-cost laptops, it includes a 14.1in panel capable of covering 91% of the sRGB gamut and 67% of the DCI-P3 space. Whites even look white.

That isn't the end of its talents, as it reaches an impressively high 361cd/m^2 peak brightness with an average Delta E of 0.78. Those are the kind of figures we expect from £1,000 laptops, not ones costing under £400. Add a contrast ratio of 1,598:1 and the only cause for potential hesitation is its glossy finish; this does cause reflections when dark scenes appear onscreen.

LEFT The screen can be rotated by 360° to create a quasi tablet

It isn't the fastest machine in the world, but that shouldn't be a surprise with a low-power Core i3-1011U processor in charge. Even with a meagre 4GB of RAM and Windows 11 Home in place, though, we suffered no stutters whatsoever. A score of 67 in the *PC Pro* benchmarks emphasises that it's no slouch, and its single-core result of 1,006 in Geekbench 5 isn't far behind the 1,102 of the Swift 3 with its AMD Ryzen 5 chip. It's only when you push the GeoFlex 340 with dozens of open tabs or in more strenuous tasks that you notice its limitations; a dual-core chip is designed for less demanding usage.

It isn't designed for games, either, relying as it does on Intel's creaky UHD integrated graphics. This offers all the acceleration of a geriatric hamster, stuttering to 15fps in *Dirt: Showdown* and and 8fps in *Metro: Last Light*. It wouldn't even complete the 3DMark Time Spy test, and drizzled its way to 714 in the older, DirectX 11 Fire Strike benchmark.

Then we come to the curious topic of storage. Geo only includes 128GB via a 2.5in SATA drive, which is why it performed so poorly in the AS SSD storage benchmarks (*see p92*). Fortunately, in day-to-day use this lack of pace isn't an issue, but the limited storage may well prove to be. How sensible of Geo, then, to include expansion via an M.2 slot that you can access from the underside of the chassis by removing two screws.

We tried to access the laptop's innards to see what else could be upgraded or repaired, but this laptop isn't designed for such things. We're sure it's possible with the right tools (we used an iFixit kit), but even after removing 14 crosshead screws we could only peer inside. Nor does Geo provide a proper user guide: head to the help centre at **geo-computers.com** for a frankly pointless two-page PDF.

BELOW The GeoFlex 340's keyboard is functional rather than luxurious

You may find yourselves in need of support, too, with this laptop proving unreliable during our battery tests. Sometimes it would drain and recharge happily. Other times it sat at 1% and refused to budge. Note that you can't recharge this laptop via the single USB-C port (rated at a lowly 5Gbits/sec for transfer speeds), instead relying on a 40W power brick with a fragile-looking pin. This weighs just 283g, which is fortunate as you'll need it on your travels: expect around six hours of life from the battery under general use.

That USB-C port is also your only route to powering an external display, with no HDMI port here. And ports are in short supply as a whole: there's a USB-A connector on the right, along with a microSD card slot, but aside from a 3.5mm jack that's your lot. You may decide to use this as the speakers are distinctly weedy.

Don't expect the world's best keyboard either, with plenty of rattle and no "feel" to the keys. It's functional rather than luxurious. Still, it's good to see separate keys for Home, PgUp, PgDn and End, with the only bugbear in terms of layout being the single-height Enter key. The trackpad is large, too, even if its clicks again give this laptop a cost-cutting air.

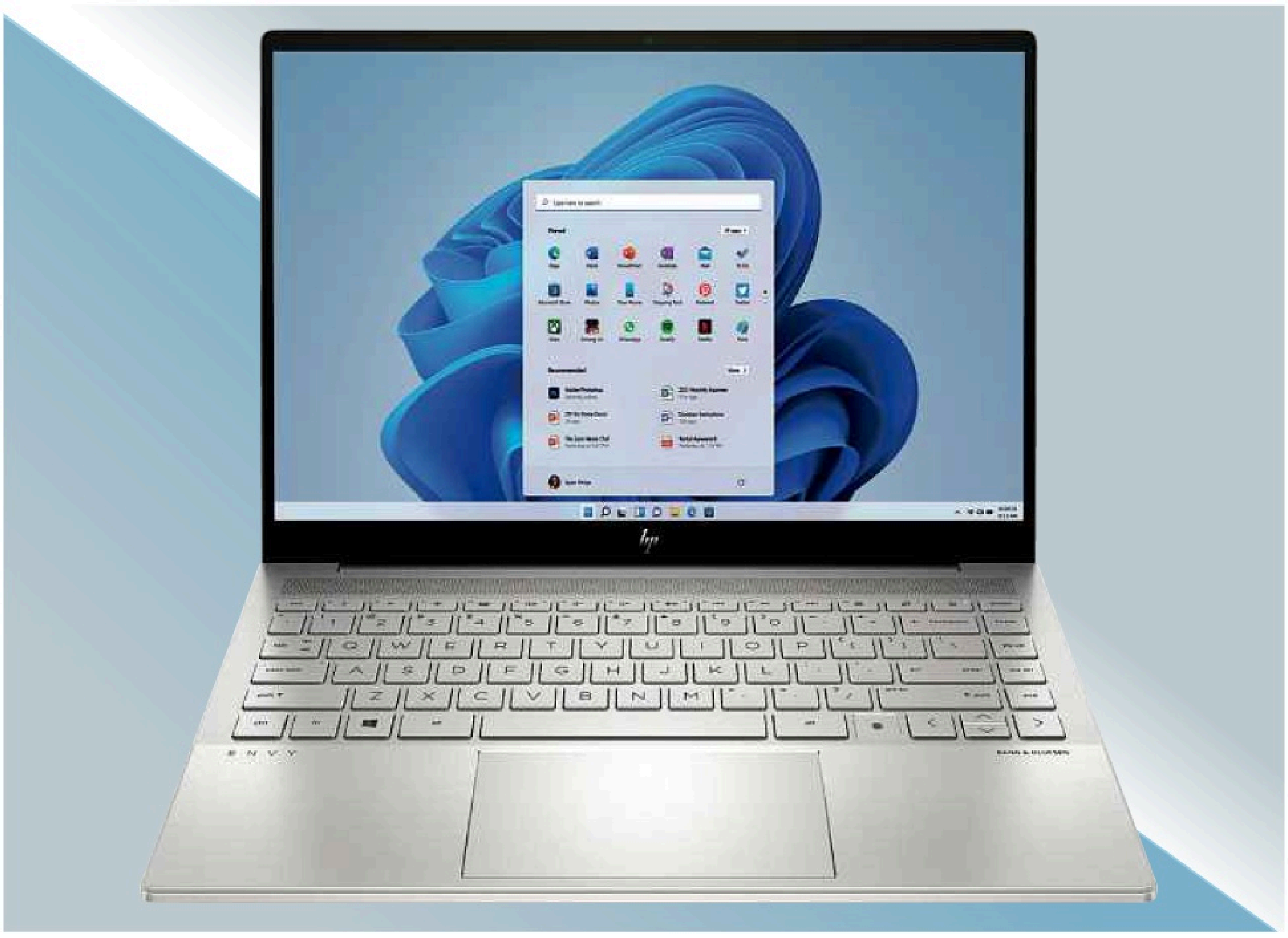
So long as you're aware of what you're buying, there's a lot to like about the GeoFlex 340. Will it give you many years of flawless service? Frankly, we doubt it. But if you're on a limited budget and want all the features that a convertible laptop brings, then you'll be pleasantly surprised. Just keep the receipt in case something goes wrong.

HP Envy 14

Equally at home playing games and films as it is tackling a day's work, this is a top-quality offering

SCORE ★★★★☆

PRICE £1,167 (£1,400 inc VAT)
from hp.com

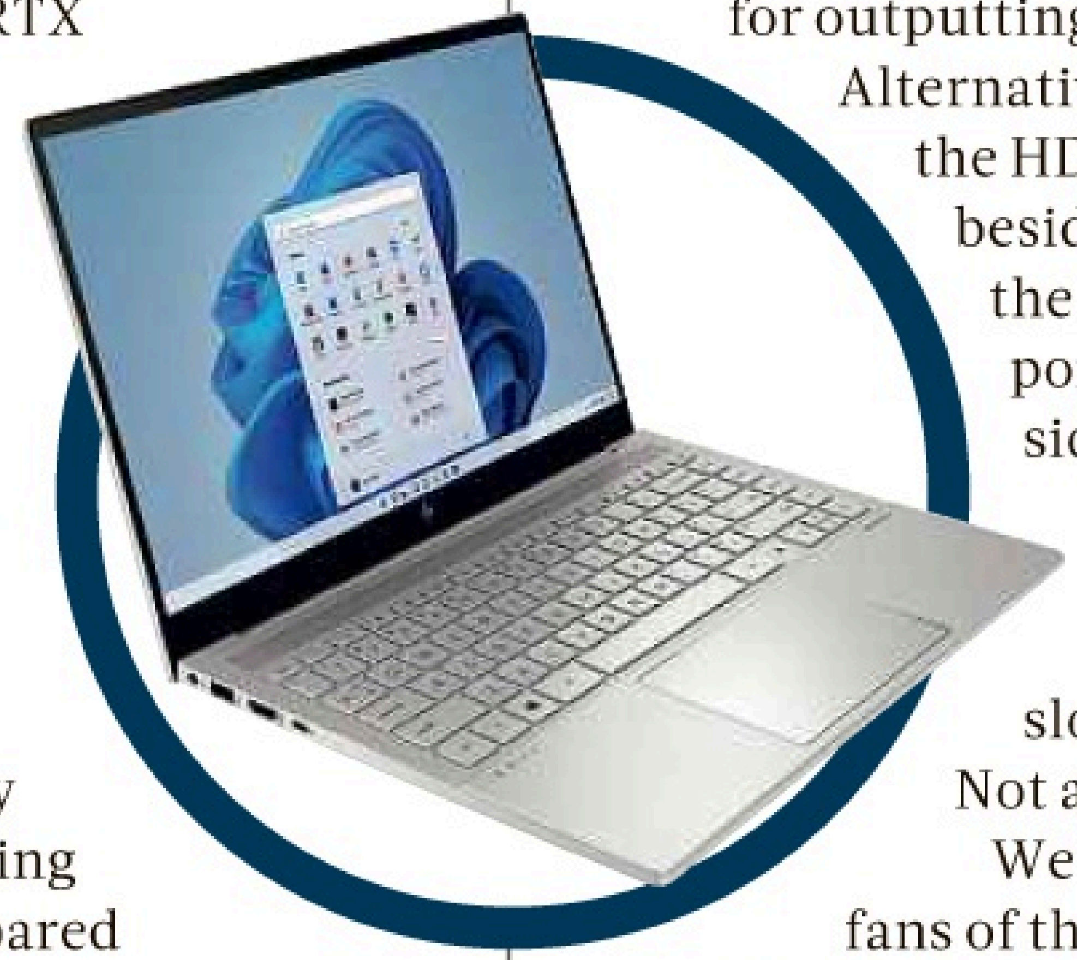


ABOVE The Envy 14 provides plenty of firepower for the price

The HP Envy range has been a regular on the *PC Pro* A List, often offering amazing quality for the money. With a starting price of £1,100, the latest iteration of the Envy 14 range falls short of that description, but if you're after a powerful machine with luxury trimmings, then read on.

Let's start with the power on offer. Our test system included a Core i7-1165G7, 16GB of RAM, a 1TB SSD and discrete GeForce GTX 1650 Ti graphics. As such, it's no surprise to see it near the top of every speed-test graph (*see p92*). If you're after firepower, this is a superb choice.

It even qualifies as a gaming laptop of sorts thanks to that GeForce chip, which is based on Nvidia's older GTX technology (so not RTX with its raytracing abilities) and meant the Envy actually beat the Asus TUF Dash in *Dirt: Showdown* at 1080p. Admittedly, the newer and more technically demanding *Metro: Exodus* put the Envy back in its box, scoring 31fps at 1080p compared to 73fps for the Asus.



LEFT The high-quality keyboard makes typing a real pleasure

If gaming isn't so important to you, then you should consider buying that cheaper version of the Envy 14. This still includes a Core i7 processor and 16GB of RAM, but drops the storage to 512GB and relies on Intel's integrated Iris Xe graphics. As can be seen from the other laptops here that use Intel's accelerator, it still offers enough grunt for playable rates in many games.

What's most impressive about the Envy 14 is that it offers all this power without sacrificing portability. Sure, it isn't the sleekest or lightest laptop here – it's 17.9mm thick and weighs 1.6kg – but a typical battery life of almost ten hours shows that you won't be searching for a plug socket all day. If you want a quick top-up, then throw the chunky 135W charger into your bag, which promises 50% capacity in half an hour, but you can charge via the USB-C port on the left side of the chassis at a push.

It would have been nice to have more than one such port, but it's a flexible beast as it can also be used for outputting to a monitor. Alternatively, you can use the HDMI port that sits beside it. HP splits the pair of USB-A ports on either side of the chassis, with a 3.5mm jack and microSD card slot on the right. Not a bad haul.

We're even bigger fans of the keyboard, which is arguably the best of this Labs. The keys have a cushioned, quiet action, and when coupled with the excellent layout (let's not quibble over the single-height Enter key), this is a laptop we would be delighted to use if forced to write a 100,000-word novel on it. We would add a mouse, though, as the trackpad's clicking action feels comparatively cheap.

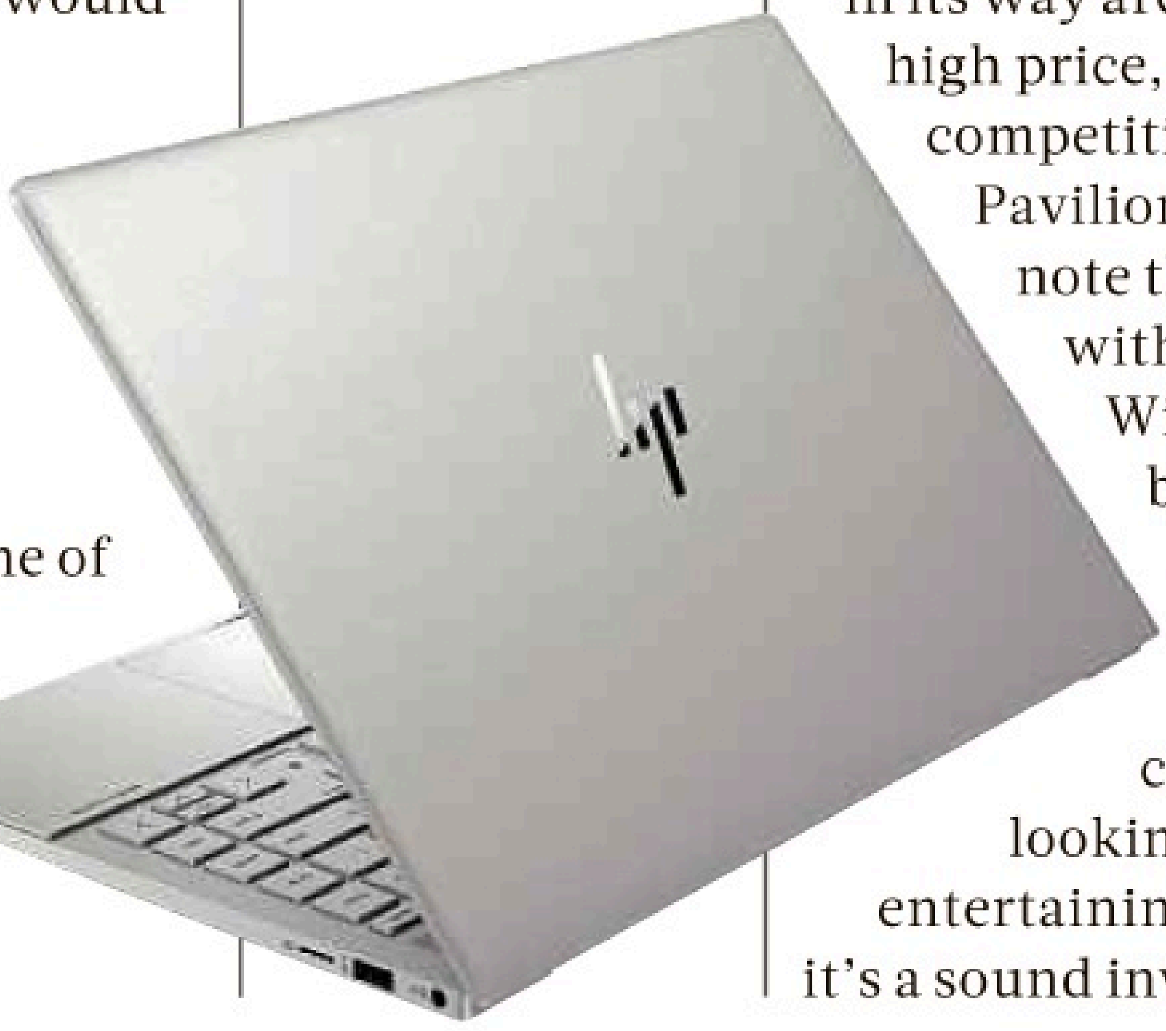
The screen doesn't quite reach the heights of the keyboard, in part because of the glossy finish and visible overhead lights, but it's still one of the best on test. Whites look white, and it covers 97% of the sRGB gamut with an average Delta E of 0.51; both commendable figures. It's also pretty bright, reaching a 381cd/m^2 peak in our tests.

This all means that movies look great, and we have more good news if you're looking for a laptop to entertain you: the speakers are excellent. They're downward-firing from the sides, which means they work best when you place the Envy on a hard surface rather than resting on your lap, but it's worth the effort – and likewise for music, with this laptop one of the few that's capable of handling delicate classical tunes along with bass-heavy tracks.

Audio is sadly the star of this laptop's webcam show as well, with the usual compressed mushy video to contend with. HP has committed to improving this aspect of its laptops in future releases, and in truth it's no worse than any other here. It doesn't support Windows Hello for facial recognition sign-in (surprising at this price), but the large fingerprint reader to the left of the cursor keys is a capable substitute.

We like the HP Envy 14 and it came close to winning an award. Standing in its way are a trio of factors: the high price, its girth and strong competition. Including HP's own Pavilion 14 opposite. We also note that, like all the laptops with discrete graphics, Windows 11 hadn't landed by the end of our tests.

Nevertheless, this is a top-quality laptop packed with powerful components. If you're looking for a machine to keep entertaining you for years to come, it's a sound investment.



BELOW The chunky chassis at least provides space for plenty of ports

HP Pavilion 14

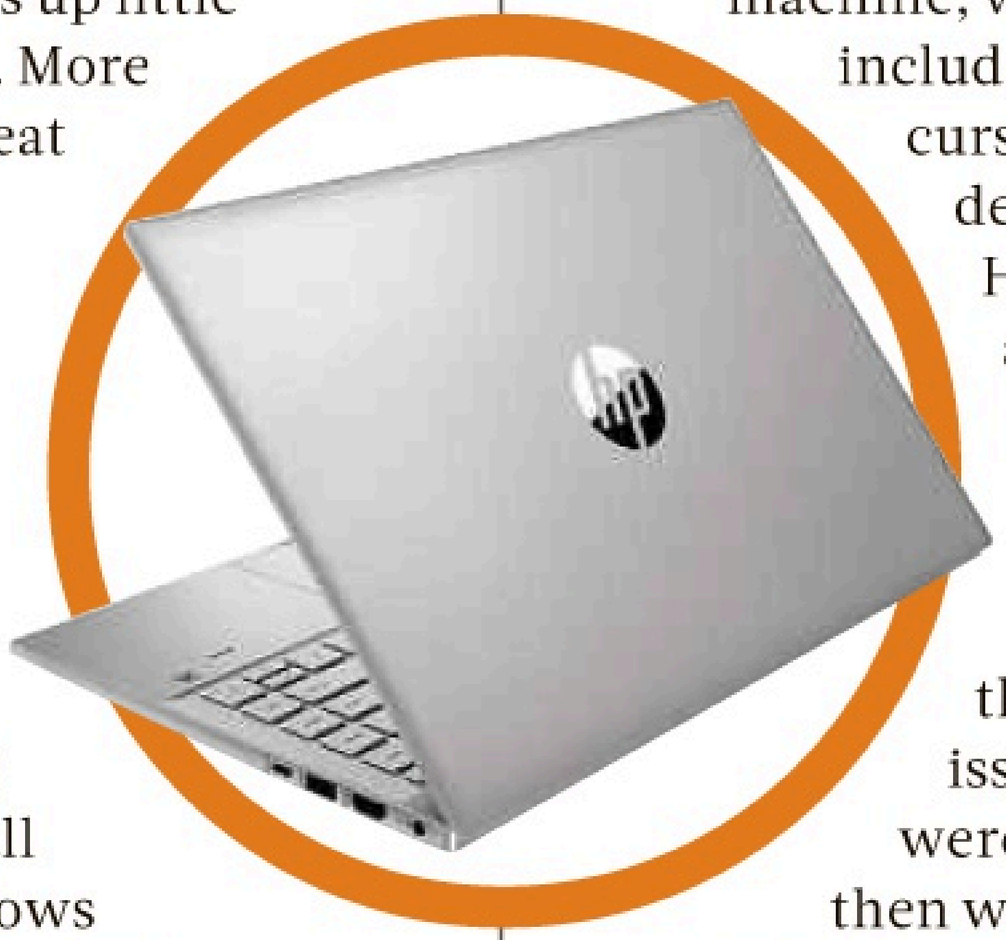
This stylish laptop has some shortcomings, but we can't argue about the quality on offer for the price

SCORE ★★★★☆

PRICE £567 (£680 inc VAT)
from hp.com

In the HP hierarchy of consumer laptops, the Pavilion range sits one step up from the bottom rung: it goes Essentials, Pavilion, Envy and then Spectre at the top. This means you miss out on some luxuries found on the Envy 14 opposite, but it looks and feels like a much more expensive laptop than its price suggests. Finished in attractive silver, an aluminium alloy lid and keyboard deck both add to the premium aroma. Put it side by side with Acer's budget offerings and there's only one winner for style.

It's a compact system as well. Measuring 17mm high and with a 1.4kg weight, it takes up little room in a travel bag. More expensive laptops beat it comfortably for screen-to-body ratio, but the side bezels only consume 7mm so are barely noticeable in use. There would have been plenty of space in the centimetre-tall top bezel for a Windows Hello-compatible infrared camera, but HP saves such nice-to-haves for its more expensive laptops.



It would have been nice to have a better webcam full stop, but this 720p unit sits in the middle of the pile in terms of quality. We don't think anyone will complain about the image on a Zoom call – they definitely won't complain about the clearly captured audio – but we hoped for more detail and less visual noise.

The 14in Full HD panel is exactly what we'd expect for a competitively priced laptop such as this. Put it next to the HP Envy 14 and it looks drab, which is due reflection of its colour coverage: 57% of the sRGB gamut compared to 97% for the Envy. And its colour accuracy is far worse, with an average Delta E of 4.49 to its posher sibling's 0.5. Nor do whites look quite so white. Still, a far fairer comparison is with similarly priced laptops, and in this company it's difficult to criticise. Especially when you consider that it's a touchscreen, which often comes in useful.

The Pavilion's keyboard wouldn't be out of place in a far more expensive machine, with highlights that include clearly separated cursor keys and dedicated buttons for Home, Pg Up, Pg Dn and End. We could be picky and call out the single-height Enter key, but in practice this didn't prove an issue to hit. And if we were being really picky then we'd say there isn't much travel on the keys themselves, and note the lack of a backlight, but we are far too polite to make such remarks. And even if we did, we would quickly move on to praise the sizeable trackpad that was tailor-made for gestures.

Of the six laptops here that include Intel's Core i5-1135G7 processor, the Pavilion 14 comes in third fastest across all our tests. The Dell XPS 13 and HP EliteBook 840 both ramp up the speeds with a higher wattage, pulling them away from competitors, but we suspect that HP believes this machine is built for modest tasks. A score of 122 in the *PC Pro* benchmarks indicates there's years of life in this laptop, and Intel's Iris Xe graphics give it enough 3D acceleration to cope with undemanding games such as *Minecraft* at 1080p. For *Fortnite*, think 720p at lower settings if you want to get above 30fps.

ABOVE **The compact Pavilion 14 will take up little room in a bag**

PC PRO RECOMMENDED

LEFT **The aluminium alloy lid gives the laptop a premium feel**

BELOW **The 14in Full HD screen is as we'd expect at this price**

There's potential to upgrade the 8GB of RAM, which is supplied as two 4GB DIMMs, but doing so involves removing the two long strips of rubber feet that provide a grip. We didn't succumb to temptation on this occasion, but HP provides a detailed maintenance and service guide that walks repairers through the steps required. It's easy enough to replace the battery, SSD, memory and Wi-Fi module, but we'd leave the fingerprint reader and display to the professionals.

This still leaves upgrade paths for anyone with a screwdriver set, and if this machine is still going after a few years you may well decide it's time to move from Wi-Fi 5 to Wi-Fi 6, for example. Or upgrade the 256GB SSD to a larger device; it's a fast reader, at 2,033MB/sec for sequential reads, but 672MB/sec for writes is slow compared to the other systems here.

Taken as a package, and one that costs a remarkably keen £680, this is the stand-out offering for anyone with around £700 to spend. And if your budget is closer to £500, then seriously consider the Core i3 version over the faster but less sophisticated Acer Swift 3.

Huawei MateBook 14s

Look out for special offers on this high-quality laptop, but it isn't worth the list price of £1,300

SCORE ★★★★☆

PRICE £1,086 (£1,300 inc VAT)
from consumer.huawei.com/uk

The Huawei MateBook 14s is so nearly the perfect laptop. For a start, it's fast: a Core i7-11370H matched with 16GB of RAM is always a powerful combination, and so it proved here with results of 164 in the *PC Pro* benchmarks and 5,327 in PCMark 10. This isn't merely due to the core components but also the highly effective cooling mechanism.

Huawei also squeezes more out of Intel's Iris Xe graphics chip than any of its rivals, with a whopping 112fps in *Dirt: Showdown* at 1080p. That's not too far behind the HP Envy 14 with its GTX 1650 Ti graphics. When you switch to more graphically intensive games – even *Metro: Last Light*, where the MateBook's 56fps was far behind the Envy's 99fps – the Iris Xe chip will struggle, but this shows the Huawei is a fine all-rounder.

It's also an attractive laptop, with an all-metal chassis finished in what Huawei describes as "space grey". Think blue-grey and you won't be too far wrong. To our eyes, the "spruce green" version is even nicer, but for reasons best known to Huawei this is only available with a 512GB SSD rather than the 1TB unit of our test machine. We advise sticking with the larger drive for speed reasons too: it topped our sequential write tests by some distance. Should you wish to replace it, removing the ten Torx screws that secure the bottom of the chassis grants you access to the slot; the RAM is soldered onto the board.

This isn't the lightest laptop on test at 1.4kg, but Huawei keeps it relatively trim at 16.7mm thick. It's deeper than usual, measuring 230mm from front to back, but that's to accommodate the 3:2 aspect ratio screen with its generous 2,520 x 1,680 resolution. And there's more: press Fn+R and and the screen switches from 60Hz to 90Hz. You can then play spot the difference when you drag windows around or play games, but in truth we struggled to see the effect.

The screen is one of the best here, covering 96% of the sRGB gamut with an average Delta E of 0.56, so the colours you see will be accurate. In fact, it put in a near-faultless performance throughout our tests: a peak brightness of 440cd/m², measured contrast ratio of 1,761:1 and 6559K colour temperature are a match for any laptop display. It's a touchscreen, too, which is literally a handy feature. Our only potential criticism is its glossy finish, but we didn't find this problematic in use.

More good news comes via the 59Wh battery, which kept the MateBook 14s going for a table-topping 12hrs 41mins in our light-usage office tests. What's more, you don't need to carry a big power supply with you: the compact 243g USB-C adapter Huawei supplies folds down neatly, and if you're in a hurry can provide three hours of charge in one 15-minute burst.

There are two USB-C ports on the left-hand side, with one supporting Thunderbolt 4 (for the Space Grey version only), along with an HDMI output and 3.5mm jack. Over on the right a solitary USB-A port sits all alone, and business buyers should note the lack of a Kensington lock slot.

ABOVE The 3:2 aspect ratio screen has a generous 2,520 x 1,680 resolution

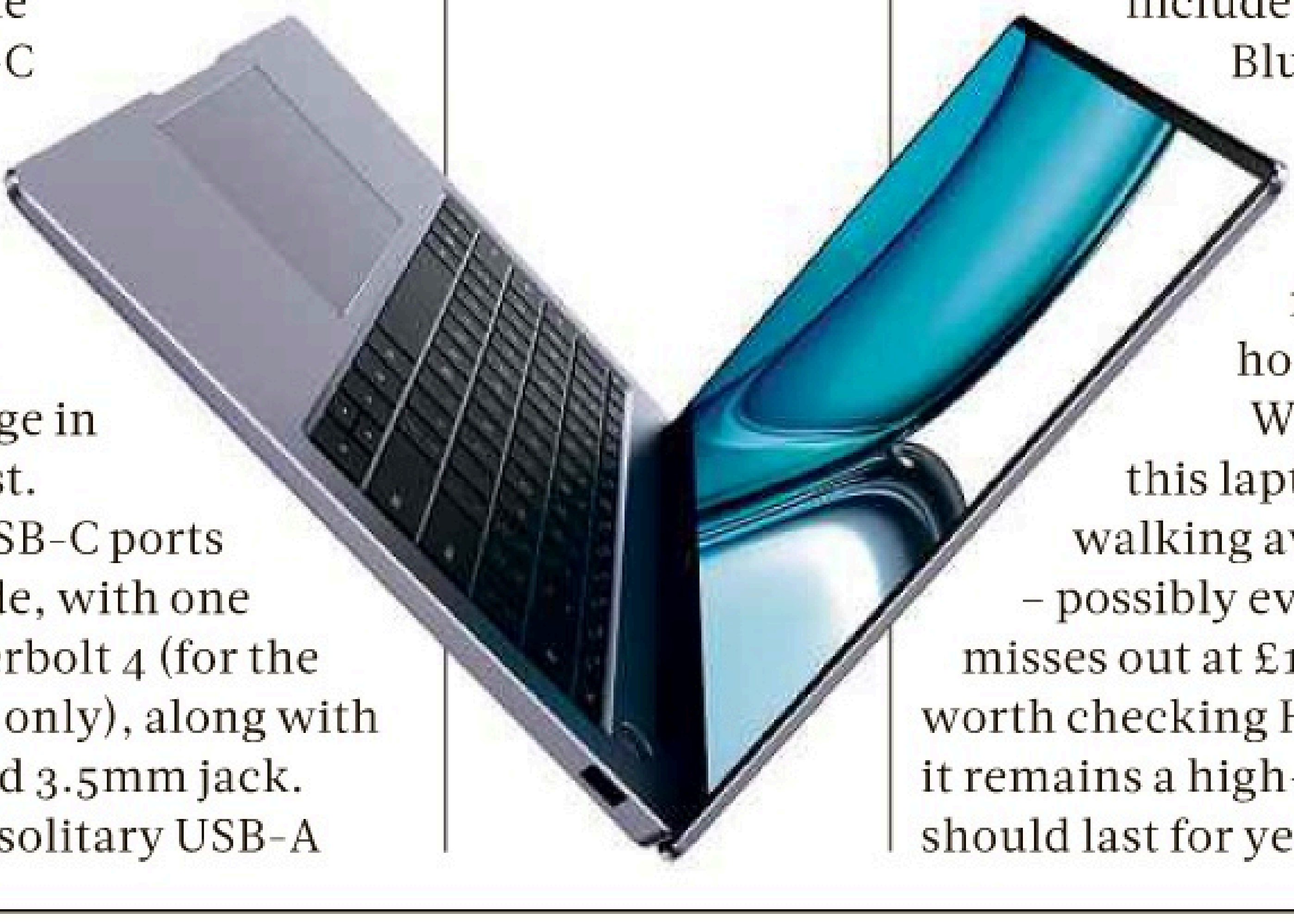
LEFT The attractive all-metal chassis gives the MateBook 14s a sturdy feel

BELOW The laptop's right-hand edge holds a solitary USB-A port

Huawei does at least provide security via a fingerprint reader (built into the power button) and a Windows Hello-compatible webcam, because – at last! – Huawei has shifted the camera position from the keyboard to above the bezel. Sadly, it also provides one of the fuzziest webcams here, with almost cartoonish compression. Audio capture is much better, and we must also praise the fine set of speakers. Music is more than listenable on this laptop.

The gentle keyboard with its large keys is easy to reach high speeds on, even if it doesn't have much travel, and we like the big Enter key, too. The touchpad is equally inoffensive.

So, there is much to like about the MateBook 14s. It's a real shame about the webcam, though, and we question the price: at one point during our testing, Huawei dropped this by £200, which makes far more sense. And although Huawei sweetens the deal with bundled gifts (these included a 10.4in tablet and Bluetooth mouse as we went to press), most buyers would surely prefer a more up-front, honest price. With a lower price, this laptop would be walking away with an award – possibly even top honours. It misses out at £1,300, but it's well worth checking Huawei's website as it remains a high-quality laptop that should last for years to come.



MSI Pulse GL66

A superb choice for gamers hunting for a sub-£1,000 machine, with sacrifices made in the right places

SCORE ★★★★☆

PRICE £749 (£899 inc VAT)
from scan.co.uk

ABOVE Although it's aimed at gamers, MSI's laptop is also a solid all-rounder

The MSI Pulse GL66 is one of two gaming laptops submitted to this Labs, and it edges ahead of the Asus TUF Dash F15 not merely due to price but also because it's faster overall. Indeed, the gaming test graphs on p93 suggest that the MSI laptop includes a faster graphics card, but in truth its chart-topping results in *Dirt: Showdown* and *Metro: Last Light* reflect that these games are limited by the CPU at 1080p.

It would be fairer to compare the two in more demanding games, where the positions were reversed. For instance, in *Metro: Exodus* the Pulse averaged 52fps while the Asus returned 73fps (at 1080p, High settings). The gap was narrower in *Shadow of the Tomb Raider*, with scores of 80fps and 88fps respectively. And note that 3DMark Time Spy showed the greater skills of the Asus laptop's GeForce RTX 3070 Mobile chip compared to the 3050 Ti Mobile in the MSI, with a score of 7,279 versus 5,693.

LEFT The chunky Pulse GL66 is built for life on a desk rather than the road

What pushed the MSI to the top of the table elsewhere is its stunning Core i7-11800H processor, as this includes eight cores to the four inside the Asus. It's an astonishing inclusion for the price, and means the Pulse has much to offer creative professionals as well as keen gamers.

One limitation of the Pulse GL66 with a 3050 Ti inside is that it includes one M.2 slot rather than the two found in more expensive variants of the brand. You can replace the 512GB SSD, but you'll need to break the factory seal. We think that's a mis-step, especially when MSI is generous enough to include a two-year warranty. At least it's only crosshead screws that then stand in your way, with the plastic bottom prising off with relative ease to reveal two SODIMM sockets – both full – and a replaceable 52Wh battery.

The combination of such a small battery and such a powerful processor was never going to be a recipe for great battery life, and with fans that kick in under even moderate duress, the Pulse came bottom in all three of our battery tests: a life of less than three hours in light use is the worst here by a distance. Then again, this chunky machine is designed for life on a table rather than the road, with a 2.1kg weight and inch-thick chassis.

Talk of mid-table brings us to the Pulse's results in our screen tests, where it sits in the median position in every single one of our results: peak brightness (341cd/m^2), sRGB gamut coverage (85%) and average Delta E (1.41). All three scores are highly respectable, and when you consider its 144Hz refresh rate we can find nothing to criticise for the price. If we were paying a few hundred pounds more then we might ask for a higher resolution than 1,920 x 1,080 – there's some fuzz to text, and viewing angles aren't the best of this group – but overall it's a great inclusion for the money.

There are a couple of game-friendly features too, including a crosshair (press the Function key plus down cursor) and a small but perfectly formed numberpad to the right of the main keyboard. The keys are backlit – useful in the darkened rooms many gamers prefer – and well proportioned, with a gentle, quiet action. It's odd to position the Fn key right next to the cursors, and the single-height Enter key is smaller than ideal, but both quirks are easy to adjust to.

PC PRO
RECOMMENDED

Likewise we can live with the compact trackpad, not least because you can plug a wired mouse into either side. Two USB-A ports sit on the left, along with a DC input, with the right home to a third USB-A port, the solitary USB-C port, a 3.5mm jack, HDMI port and Ethernet port. With 150W required it's no surprise that the USB-C port can't be used to power the laptop – you'll need to carry the 488g power brick – but note it can't output to a monitor either.

Unlike Asus, MSI finds room for a webcam. It's nothing special in terms of sharpness, but we'd be happy to use it for video calls thanks to its natural colours. The final dollop of luxury cream comes in the form of a creditable pair of speakers that didn't massacre our audio-testing playlist. Bass lacks depth, but that's its only obvious weakness.

All this makes the MSI Pulse GL66 not only a gaming bargain but also one of the best all-rounders here, so long as portability doesn't top your wish list. Nor should you expect Windows 11 right away. While it meets the requirements, we were still waiting for the update to appear when we finished testing. Still, when it does land, the Pulse GL66 has so much power it will be one of the most responsive Windows 11 laptops around.

BELOW The backlit keys are sure to appeal to gamers

PCSpecialist Fusion Studio 14in

A high-quality laptop that compares well to its big-name opposition, especially for configurability

SCORE ★★★★☆

PRICE £887 (£1,064 inc VAT)
from pcspecialist.co.uk/reviews

ABOVE At just 1.1kg, the Fusion Studio is the lightest laptop on test this month

One of the advantages of choosing a British laptop manufacturer – such as PCSpecialist – is that they have the means to customise the specification to your choice. Of the big international companies, only Dell offers the same flexibility, but similar Dell XPS 13 configurations (there's no exact match) cost £1,199 at a minimum.

Where PCSpecialist can't match the big companies is for R&D, so it relies on third-party chassis makers. In the past, the choice has been limited to chassis that feel a generation or two behind the likes of Dell and HP, but the Fusion Studio is a match for style and finish. For a start, it's made from a full-body magnesium alloy chassis, and aside from the lid – which has some obvious flex – it feels very sturdy.

LEFT The quiet keyboard offers a two-level backlight

Nor does this build quality translate into weight, with the Fusion Studio tipping our scales at 1.1kg. That's lighter than the Dell XPS, or indeed any other laptop on test this month. Where it falls behind is for battery life, with a result of 6hrs 31mins in our general office test. The other disappointment is that it can only be charged via the supplied DC power brick, which is heavy at 515g.

We hoped it would charge via the USB-C ports on either side of the chassis, but the right-hand connector is restricted to data transfers (a fast 10Gbits/sec) while the left Thunderbolt 4 connector can output to a monitor but doesn't deliver power. An HDMI output sits on the right, where you'll also find a USB-A port (10Gbits/sec) and the DC input. The left-hand side offers a second USB-A port, full-size SD card slot and 3.5mm jack.

There are yet more expansion opportunities beneath the bottom panel, which is blissfully easy to remove: six crosshead screws stand in your way, and then the panel lifts off without any need for tools. It's a relief to see two SODIMM sockets available, rather than having memory soldered onto the motherboard, and as PCSpecialist configured our test machine with one 8GB module, that's easy to double to 16GB. Or configure it yourself at the time of purchase for an extra £36. Or go wild and choose 64GB for a total price of £1,340.

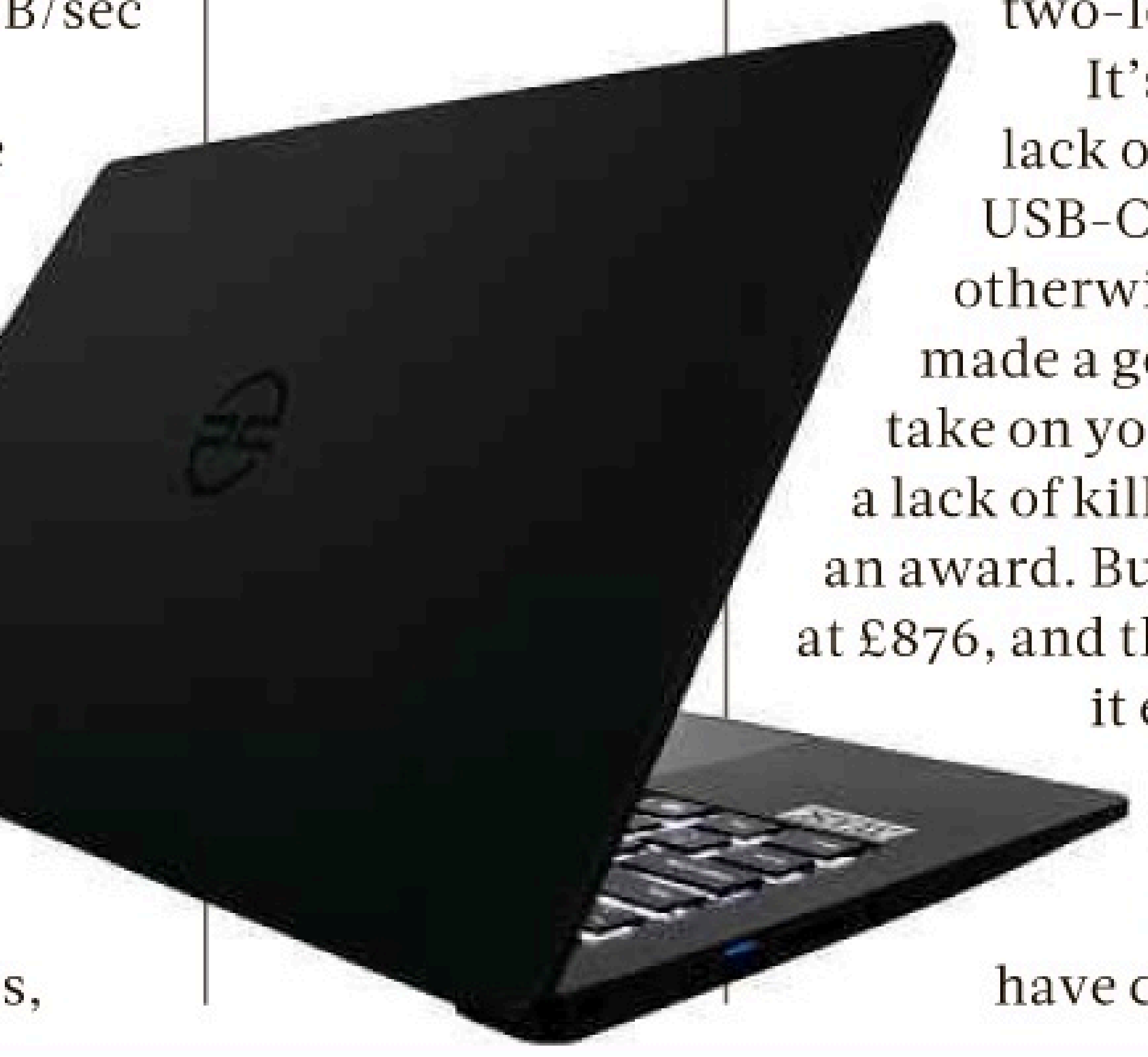
You can also configure the Fusion Studio 14in with two M.2 SSDs, with an easily accessible slot sitting on the motherboard. There shouldn't be any immediate need to do so, however, as PCSpecialist supplies 1TB as part of this configuration, and again you can upgrade this at the time of purchase (for example, a 2TB Corsair unit adds £122 to the price).

If you intend to use this laptop for tasks that involve intensive writing to disk, then you may want to upgrade the supplied PCS SSD to a higher-spec Corsair MP400 anyway: sequential read and write speeds of 1,429MB/sec and 1,209MB/sec may prove a bottleneck. This, along with the 8GB of RAM, is one reason the Core i7-11370H didn't shine in our benchmarks, with the Fusion Studio consistently sitting below laptops powered by the Core i5-1165G7 in intensive tests.

We would also steer you to other laptops if you intend to play demanding games, with this configuration of Intel's Iris Xe graphics again falling behind its counterparts in 3DMark's Time Spy test and both our in-game benchmarks: 50fps in *Dirt: Showdown* shows that it can handle less punishing games, but don't set your expectations too high.

That average fell to 26fps at the Fusion Studio's native resolution, but that's to be expected because it's a gorgeously detailed 2,880 x 1,800. It's a high-quality panel, too, covering 99% of the sRGB space and 81% of DCI-P3. Combine that with an average Delta E of 0.34 and a peak brightness of 407cd/m^2 and it's a match for any screen here. It also supports 90Hz refresh rates and minimises reflections thanks to its matte finish.

There's no touchscreen, but gesture lovers will appreciate the huge trackpad below the keyboard. We were concerned about palm interference while typing, but that was never a problem during our time with the Fusion. The keyboard itself sits in the friend zone, with a quiet action and excellent layout (note the big Enter key and separated cursors), and while it lacks the cushioned feel of the best keyboards, it's pleasant to use for prolonged periods. There's a two-level backlight, too.



BELOW The Fusion Studio is a solid, well-built laptop

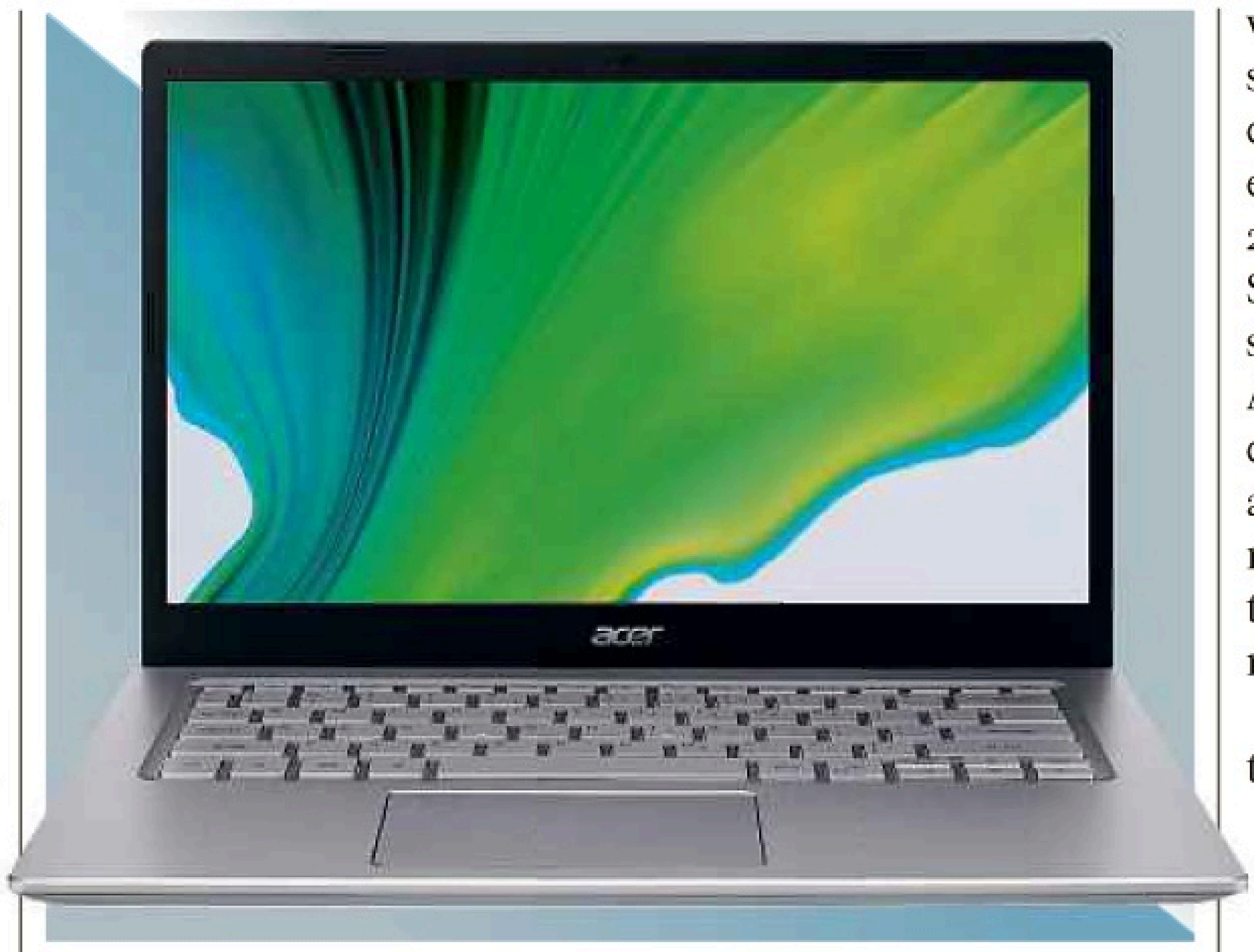
It's a shame about the lack of battery life and USB-C charging, because otherwise this would have made a gorgeous machine to take on your travels. It's this, and a lack of killer pace, that robs it of an award. But with prices starting at £876, and the ability to configure it exactly to your liking, this is arguably the best British-assembled laptop to have crossed our paths.

Acer Aspire 5 A514-54

Acer needs to upgrade the Aspire 5 chassis, which is looking tired even for a budget machine

SCORE ★★★☆☆

PRICE £499 (£599 inc VAT) from currys.co.uk



ABOVE The Aspire 5's chassis is chunky and looks dated

The Acer Aspire 5 chassis – the A514-54 on test is one variation of many that Acer sells – has been largely unchanged for years, and it's showing its age. The metal effect finish of the plastic chassis fools no-one, while the high-contrast black bezels around the screen simply look large. And while Acer quotes an 18mm height, it's closer to 20mm in many places. At 1.7kg, this is a chunky machine by modern standards.

First impressions aren't improved by a lacklustre screen. Whites aren't true, and even when we pushed the brightness up to its 264cd/m^2 maximum – and tweaked its colour balance in software – this wasn't a panel that brought joy to our eyes. If you plan to watch films on your laptop, then again we suggest steering clear, but this time due to a pair of tinny speakers.

We've seen worse webcams than the 720p unit here, which suffers from noise (as do so many of this month's contenders), but it does at least capture natural looking colours. You won't be embarrassed making video calls on it.

And there are other positives. With an 11th generation Core i5 in place, it's a nippy machine that performed creditably in all our benchmarks, while only 11 crosshead screws separate you from the internals. You can add a 2.5in SATA drive into an empty bay, replace the supplied 256GB M.2 SSD or upgrade the 4GB SODIMM (4GB of memory is also soldered onto the motherboard). Acer spoils you when it comes to connectivity too, with Wi-Fi 6 inside and five handy ports on the left of the machine: Gigabit Ethernet, HDMI, two USB-A ports (a third sits on the right) and a USB-C port.

Don't expect great speeds from the USB ports, however, as they're stuck on the old USB 3.1 standard, confusingly rechristened USB 3.2 Gen 1, and that means a theoretical 5Gbits/sec maximum. The USB-C port is strictly for data transfers, too, with no support for Power Delivery or monitor connections. That's a disappointing omission.

We were also left wanting when it came to Windows 11, with no support for this system by the time we concluded our tests in early January. An update should come, as the laptop is fully compatible, but you may have to wait a while.

Sadly, this all adds to a feeling that this laptop is falling behind the times. Especially when the HP Pavilion 14 offers a far more compelling package for a similar price.

Acer Swift 3 SF314-43

Despite some signs of cost-cutting, there's much to tempt anyone looking for power on a budget

SCORE ★★★★☆

PRICE £583 (£699 inc VAT) from currys.co.uk

ABOVE The Ryzen 5 CPU helps the Swift 3 live up to its name

If you're on a tight budget and need multicore power, then nothing ticks the boxes quite like this AMD-powered Swift 3. The Ryzen 5 5500U is the key to its success, with six cores and 12 threads ensuring it whips through multicore tasks in no time. That's despite the limiting 8GB of RAM, which is soldered onto the motherboard (there's no SODIMM socket so no upgrade route). AMD's Radeon Vega 7 graphics can't match the CPU for potency, but a 77fps average in *Dirt: Showdown* shows that it has some gaming prowess.

Anyone who thinks you need to choose Intel for battery life should also take note of this laptop's fine performance in our video-rundown test, where it kept going for 11hrs 24mins, even if that figure dropped to 8hrs 7mins in office duties. It's compact and light, too, measuring 15.9mm thick and weighing a discreet 1.2kg. What a shame you can't power it via the USB-C connector, which means you'll need to lug the 344g DC power supply on your travels.

Acer also finds room for two USB-A ports, one on either side, plus an HDMI output on the left. You can use the USB-C connector to hook up a monitor too. This neatly bypasses one of the Swift 3's relative weak points, namely the 14in, 1080p screen. It covers only 53% of the sRGB gamut, colour accuracy is poor and a 925:1 contrast ratio is the worst we measured on test.

This means the Swift 3 wouldn't be our top choice for photos or films – hollow speakers don't help here – but pleasant-looking whites mean we'd be more than happy to use it for office duties. And surprisingly it packs one of the best keyboards, too. There isn't much travel, but the action is nicely cushioned and there's a backlight if you need it. The trackpad is more basic and clicky.

As with the Aspire 5, where Acer lets itself down is the design. The obviously fake metal-effect plastic gives the Swift 3 a cheap look, which makes you wonder how long it will last under duress. Still, Acer beats the industry average for laptop reliability in our annual survey (*see issue 326, p26*), and the lid is made from metal to protect against in-bag bashes.

You can't expect luxuries such as facial recognition at this price – nor a great webcam, unless you're fond of drab colours – but the tiny fingerprint reader works well. And we've saved the best to last: the Swift 3 we reviewed (part code NX.AB1EK.007) comes with a 1TB SSD yet still costs £699. A Ryzen 3 version with a 256GB SSD costs £529. So long as you can live with its limitations, this is a great-value offering.

Asus TUF Dash F15

The RTX 3070 Mobile will bring big benefits, but the MSI Pulse is our pick of this month's gaming laptops

SCORE ★★★★☆

PRICE £1,000 (£1,200 inc VAT)
from box.co.uk

ABOVE The TUF Dash excels when it comes to playing AAA games

If the MSI Pulse wins for value – and it most definitely does between the two gaming laptops on test – then the Asus TUF Dash F15 wins for fit and finish. By comparison it screams luxury, whether that's through a delightful soft-touch keyboard (complete with highlighted WASD keys) or the top-quality trackpad with its super-smooth finish. We suspect you'll enjoy using the TUF Dash if you buy it.

While the screen didn't excel in our technical tests, there's much to like from a gamer's point of view: support for adaptive sync and a 144Hz refresh rate make it a fine choice for the powerful gaming components inside. Chief among these is Nvidia's GeForce RTX 3070 Mobile chip, which includes 8GB of memory, and that more or less guarantees playable frame rates at the screen's native 1080p in even the most demanding games. That isn't true for the GTX 3050 Ti in MSI's cheaper system.

As we noted in the review of the MSI Pulse, however, that laptop's superior processor helped push up frame rates in CPU-limited games such as *Metro: Last Light*. The TUF Dash F15 must also make do with a mere four cores, which is what held it back – comparatively – in media-focused benchmarks such as *PC Pro*'s and the PCMark 10 Digital Creation test (*see the graphs on p92*). Still, the TUF Dash is a powerful system by almost any metric.

We also appreciate the fact that Asus supplies a self-repair manual for the TUF Dash F15. Admittedly, it's overkill to have 16 crosshead screws securing the base, and once you battle past them you'll discover that 8GB of RAM is embedded on the motherboard; not ideal if something goes wrong with it. You can at least replace the supplied 8GB SODIMM. There's no second M.2 slot, either: you must again replace the supplied 512GB SSD if you need more capacity. Fortunately, the single USB-C port supports Thunderbolt 4 for speedy external storage.

This port can also be used to charge the TUF Dash, which destroyed the MSI in both our non-gaming battery tests: expect around nine hours to the three hours of its rival. It's level pegging when it comes to gaming, though, with life expectancy dropping to a paltry hour. Neither machine is ideal for a travelling life, but the F15 is notably less chunky than the MSI Pulse and benefits from a 2kg weight compared to the 2.1kg of its rival.

It misses out on an award, but we like the Asus TUF Dash F15: it's a high-quality laptop that can handle AAA games, which is quite something for the price.

Chillblast Fusion Iris

Bags of power for a mere £800, but rivals offer a more refined experience that's worth paying extra for

SCORE ★★★☆☆

PRICE £667 (£800 inc VAT)
from chillblast.com

ABOVE The Fusion Iris is let down by its poor-quality screen

There is only one reason to choose the Fusion Iris, and that's if your top priority is bang-per-buck. With a Core i7-1165G7 processor and 16GB of RAM, it rivalled far more expensive machines in our non-gaming benchmarks. Our only caveat is that Acer's Swift 3 more than lived up to its name thanks to a six-core Ryzen chip inside, and that machine costs £101 less than the Fusion Iris.

Those looking for a gaming system would be far better served by the £899 MSI Pulse GL66, which offers a major upgrade in the form of the discrete Nvidia GeForce RTX 3050 Ti chip versus Intel's integrated Xe graphics. For example, the MSI scored 170fps in *Metro: Last Light* compared to the Chillblast's 43fps.

But the biggest problem for the Fusion Iris is its screen. We didn't need the technical tests to see that this is a deeply mediocre panel, with washed-out colours and poor viewing angles immediately marring its appeal. It actually outperforms some rivals for colour coverage and accuracy, but a peak brightness of 239cd/m² is low and a colour temperature of 8429K far away from the 6500K we hoped for.

The keyboard is more acceptable. If we were being picky we might ask for more separation between the slimline numberpad and the main keys, but there's a handy backlight and the action is fine unless you land with force: hitting with a heavier touch makes it loud and clicky. It's always good to see a large trackpad as well, but a cheap-sounding click will be a constant reminder of this laptop's budget origins.

This isn't a machine designed for life on the road either, with the 54Wh battery proving enough for only between six and seven hours in our tests. Nor can you charge via the USB-C port, but at least it provides fast 10Gbits/sec data transfers and connects to a monitor.

There's also an HDMI output and three USB-A ports, making a physical Ethernet port the only obvious omission in terms of connectivity.

This price includes a 500GB SSD – the Acer Swift 3 doubles that – but it's simple to access the Fusion Iris's innards if you want to upgrade the Samsung unit that Chillblast supplies. Notably, this proved to be one of the fastest in our tests.

Ultimately, it's the screen that lets this laptop down. If you want screaming performance then choose the MSI Pulse GL66 or the Acer Swift 3. And if you're looking for a big-screen laptop on a budget, the PCSpecialist Lafité Pro opposite is a more sensible choice.

HP EliteBook 840 Aero G8

A top-quality laptop best suited to bigger businesses thanks to HP's security and management tools

SCORE ★★★★☆

PRICE £1,563 (£1,876 inc VAT)
from bechtle.com/gb

This is a business laptop that screams quality from every pore. Its slim chassis is built using magnesium, which is why it's so solid yet so light: at 1.2kg you can slip the EliteBook 840 Aero into a briefcase or rucksack without feeling weighed down. (The "Aero" indicates that this is the lighter variant of the standard 840.) You probably won't even need to bring the power supply with you as it lasted for a dozen or so hours in both of our light-use tests.

Don't think it lacks power, either. Our test unit included a Core i5-1135G7, 16GB of DDR4 RAM and a 512GB SSD, which pushed it to a nippy 143 in the *PC Pro* benchmarks and 4,846 in PCMark 10. This spec is still available from other retailers, but if you buy an 840 Aero direct from HP then your choices are, at the time of going to press, a Core i5/8GB/256GB version for £1,139 or a Core i7/16GB/512GB option for £1,343.

ABOVE The EliteBook 840 Aero is a solid choice for businesses

Removing the base gives access to both SODIMM sockets and the M.2 slot. HP doesn't supply the speediest SSD but we're confident this laptop will keep Windows 11 Pro running happily for years. It comes with a three-year warranty as standard, too.

More reassurance for businesses comes via the suite of tools HP offers with its EliteBooks, which include protected BIOSes, a three-year licence of HP's Wolf Security Pro suite and comprehensive hardware protection: the infrared webcam and fingerprint reader for Windows Hello logins, plus a smart card reader on the left-hand side. There's no shortage of ports either, with two USB-A connectors on the left, two Thunderbolt 4 USB-C ports on the right, plus an HDMI output. Our sample also included a nano-SIM slot, but that isn't an option on the models bought direct from HP.

Traditionalists will also appreciate the trackpoint built into the centre of the keyboard, complete with physical left- and right-click buttons, but the star of the show is the keyboard itself. This is a joy to type on, with plenty of travel to the keys, separated out cursors and navigation buttons, plus clearly labelled function buttons.

The 14in screen is equally solid, covering 91% of the sRGB space with a peak brightness of 429cd/m^2 and excellent colour accuracy. We would have liked a touchscreen, but overall it's a fine if unexciting inclusion.

Which sums up the EliteBook 840 Aero as a whole. Its key attraction is its portability, and with strong performance allied to HP's suite of security software it should have obvious appeal to larger businesses looking for an easy-to-manage fleet.

PCSpecialist Lafité Pro 17.3in

This is a high-quality – albeit chunky – desktop replacement that offers much to buyers on a budget

SCORE ★★★★☆

PRICE £722 (£866 inc VAT)
from pcspecialist.co.uk/reviews

There is much to like about this desktop replacement, and we'll start with the 17.3in screen. We're used to lacklustre displays in sub-£1,000 laptops, but this IPS panel covers 94% of the sRGB gamut with an average Delta E of 0.79. Then consider its exemplary 6471K colour temperature, and it's no surprise that whites look gloriously white. It's bright too, hitting 414cd/m^2 in our tests. We would have been happy with 350cd/m^2, so that's a fantastic result.

There's enough power here to keep Windows 11 feeling sprightly for years to come, with a modest but effective trio of core components: a Core i5-11300H processor, 8GB of DDR4 memory and 512GB SSD. You're stuck with the processor for the lifetime of this machine, but fishing out your crosshead screwdriver and removing the bottom panel will reveal a spare SODIMM socket and second M.2 slot. Note the three-year warranty too, even if only the first year covers parts.

ABOVE The Lafité Pro: never mind the width, feel the quality

You can also replace the Wi-Fi card, but there's little reason to do so thanks to its support for Wi-Fi 6 and Bluetooth 5.2. This complements a comprehensive set of ports, including a Gigabit Ethernet connection, HDMI output, two USB-A ports and a further two USB-C ports. Both the latter sit on the left-hand side, but note that neither can supply power to the laptop and only the front one (which supports Thunderbolt 4) can output to a display.

The keyboard looks basic compared to rivals, but this belies its four-level keyboard backlight and a pleasant, quiet typing action. There's a numberpad here too, and we're also fans of the huge trackpad. Think functional rather than luxury, but that's fine for the price.

Less attractive is the Lafité Pro's sheer size, with a 2.3kg weight making it the heaviest machine here. A sizeable 73Wh battery kept it going for around eight hours in our main battery tests, but the big surprise came in its result in the PCMark 10 gaming test: 3hrs 6mins. Don't get too excited, though. This longevity reflects the laptop's unimpressive results in our gaming benchmarks, which were among the worst of the machines based on Intel's Iris Xe chip. Nor was this a star performer in any other of our tests, so think day-to-day tasks rather than digital creation.

Still, we would choose this chunky laptop over the faster Chillblast Fusion Iris opposite due to its higher all-round quality. If you don't mind girth, it's a fine buy for the money.

How we test

To better understand the graphs, it's worth understanding the exact tests we put each laptop through

We measure a laptop's performance using a range of tests. The *PC Pro* benchmark measures how quickly each system can process a standard set of image and video files, and handle multiple workloads while simultaneously playing a video. We also test using PCMark 10, Geekbench 5 and Cinebench R23.

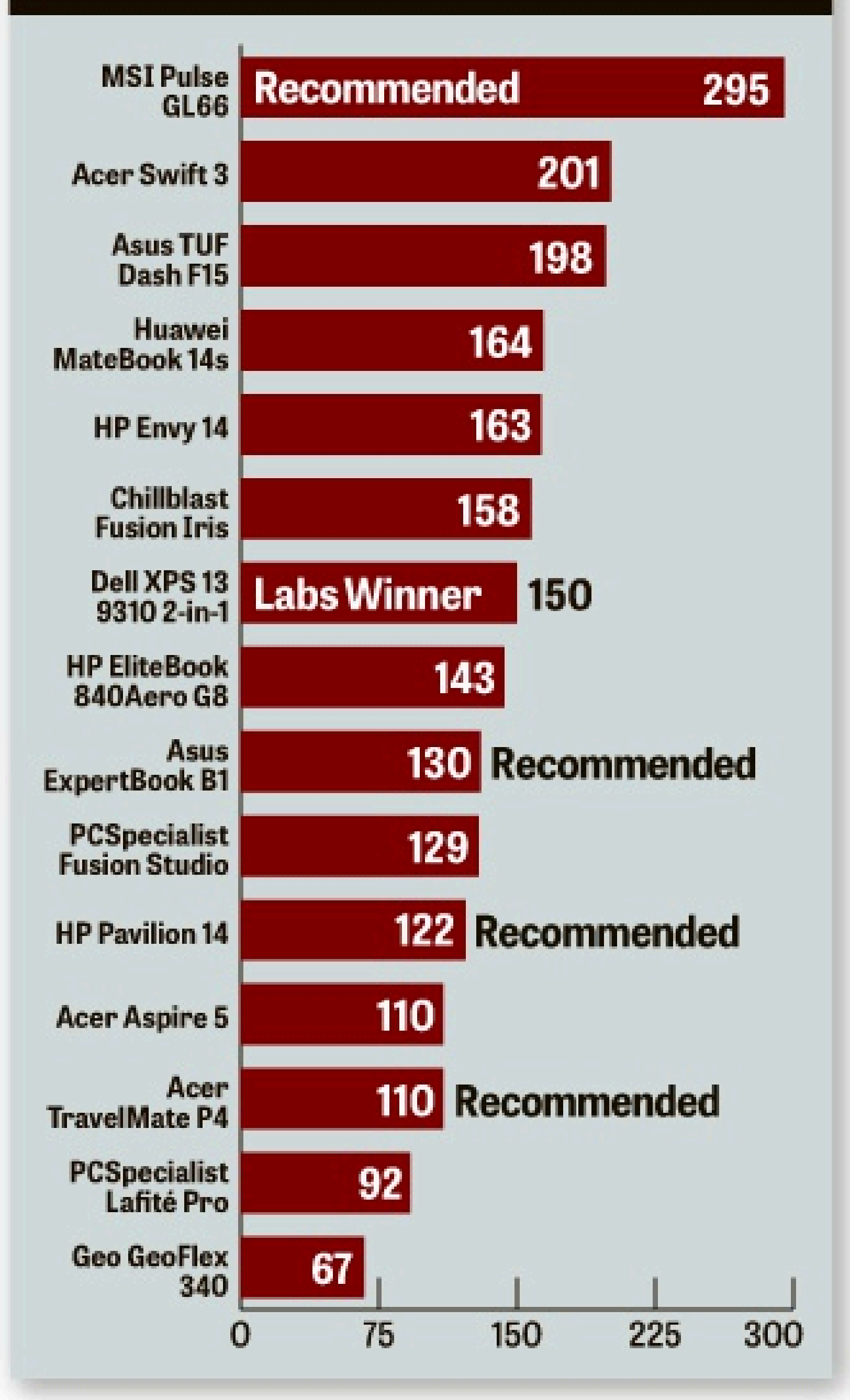
We test the internal SSD using the AS SSD tool, which determines sequential read and write speeds. This month, we also timed how long it took to transfer 11GB of mixed files via a USB-C port.

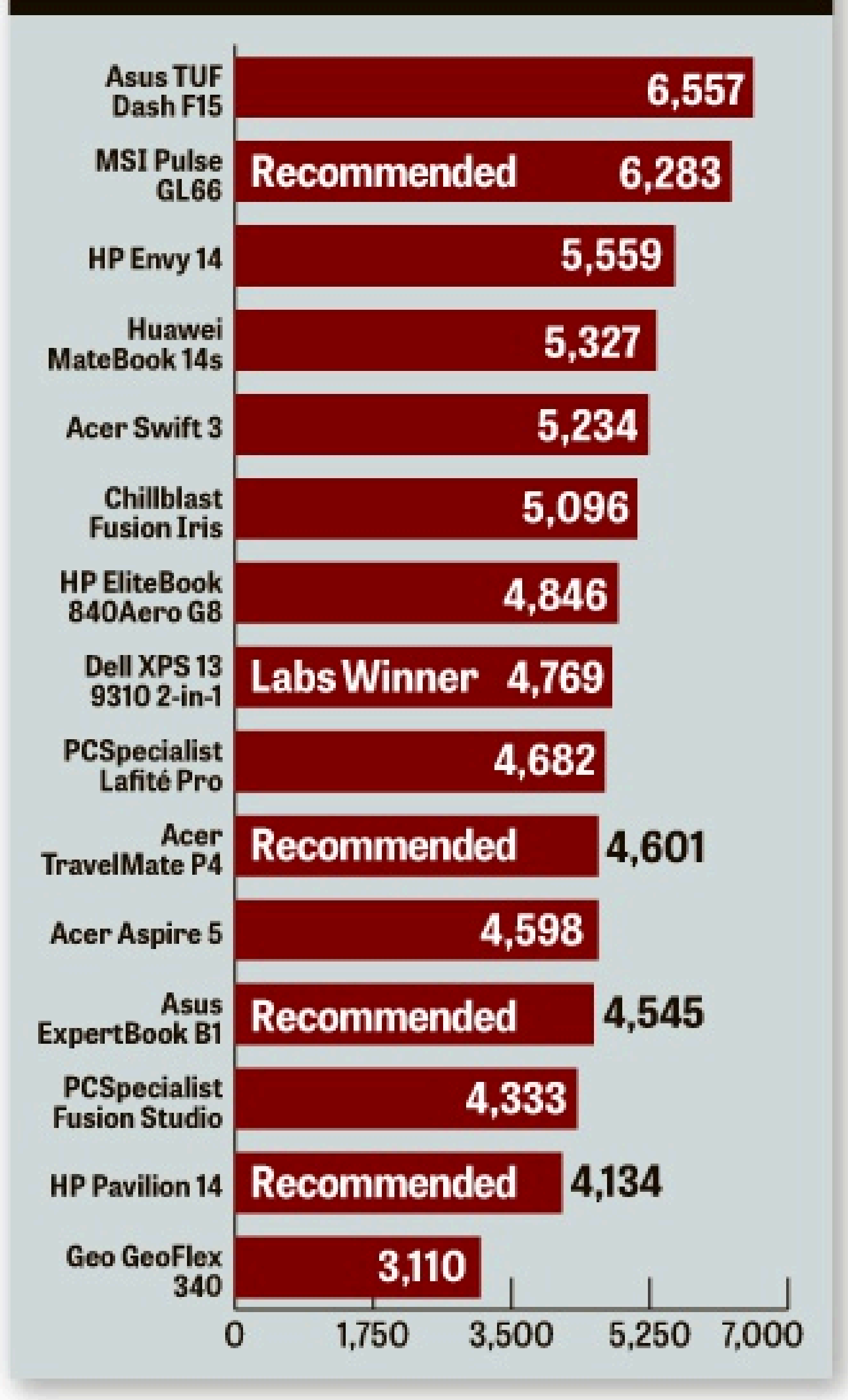
Next we test gaming performance using 3DMark, *Dirt: Showdown* and *Metro: Last Light*. If a laptop has discrete graphics, we test it in *Metro: Exodus* and *Shadow of the Tomb Raider*. All benchmarks shown here are at 1080p at High presets.

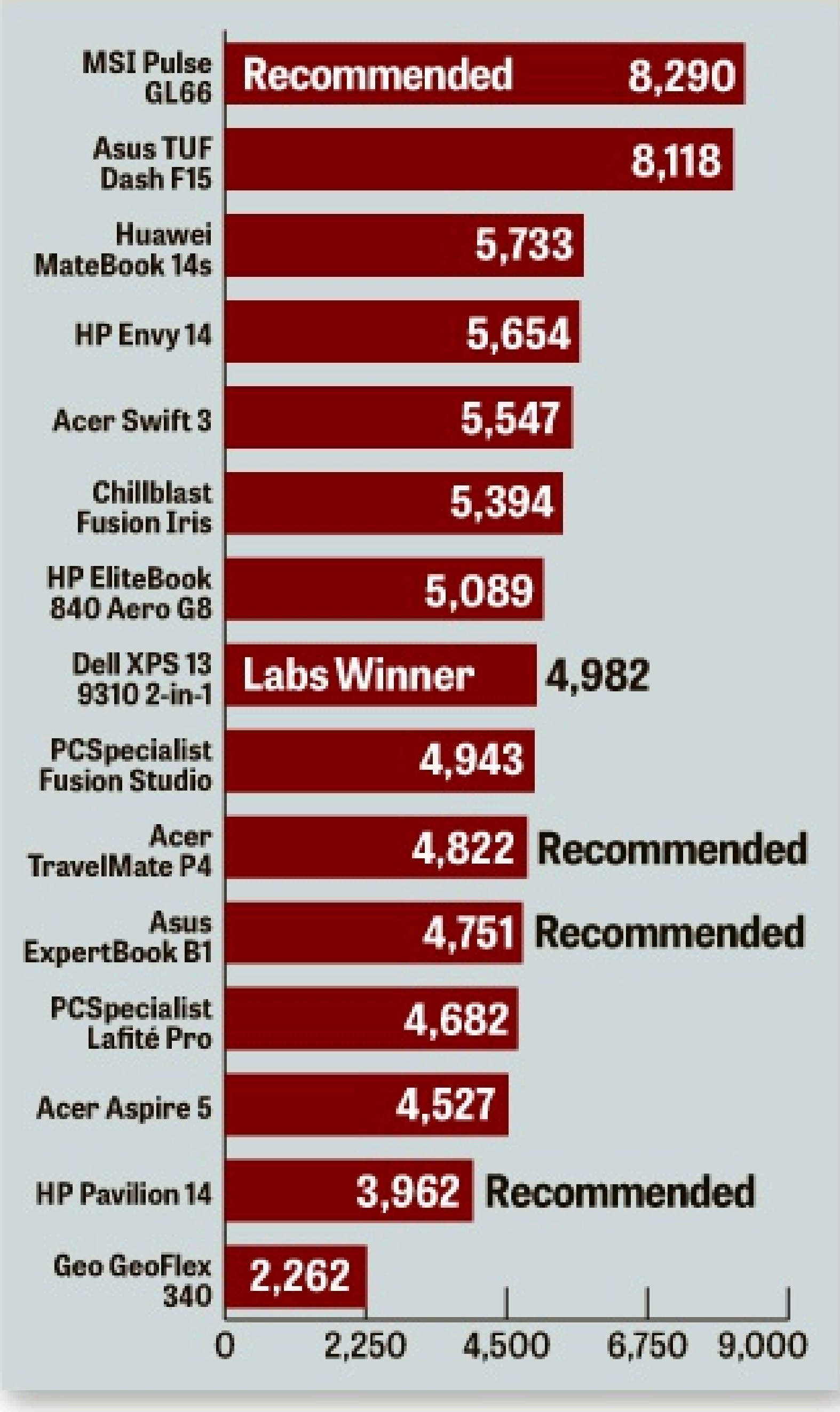
We then move on to the screen, using an X-Rite colorimeter to establish the maximum brightness the screen is capable of, along with its effective contrast ratio, sRGB coverage and colour accuracy. The latter is expressed as a Delta E figure, with a score of 1 or below representing perfection as far as the human eye can discern.

Finally, we test each laptop's battery life, using a video-rundown test and two tests built into PCMark 10. First, the "modern office" benchmarks, which mimic a working day, including video calls, writing letters and spreadsheet work. We use the Gaming test to push the graphics chip to the limit. In all battery tests, we set the screen to a brightness of 170cd/m^2 and let the laptop keep going until it reaches 5% of its battery capacity. In the office and gaming tests, we keep Wi-Fi on; for the video-rundown test, we put the laptop into flight mode.

Speed tests


PC Pro overall


PCMark 10 overall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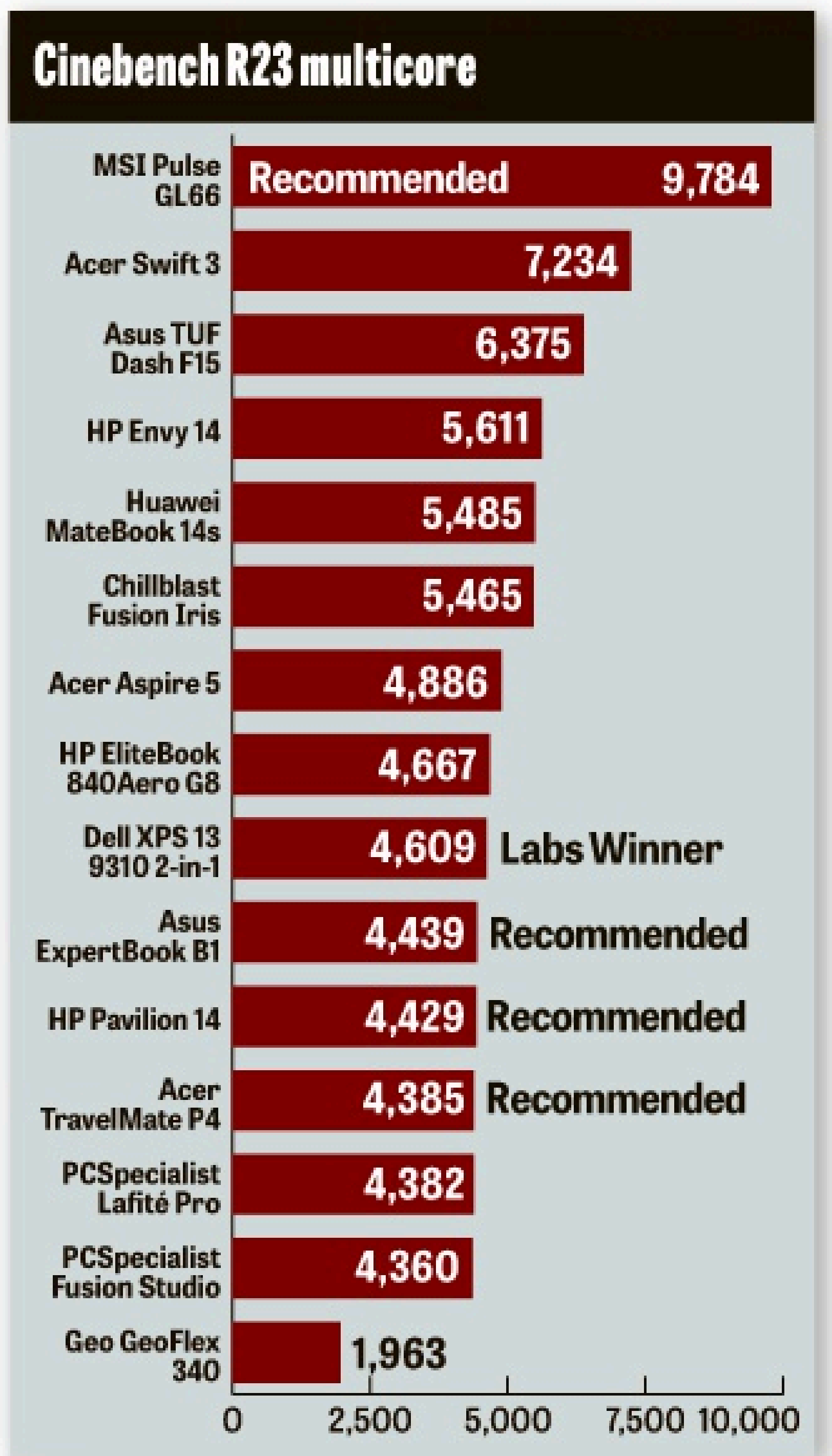
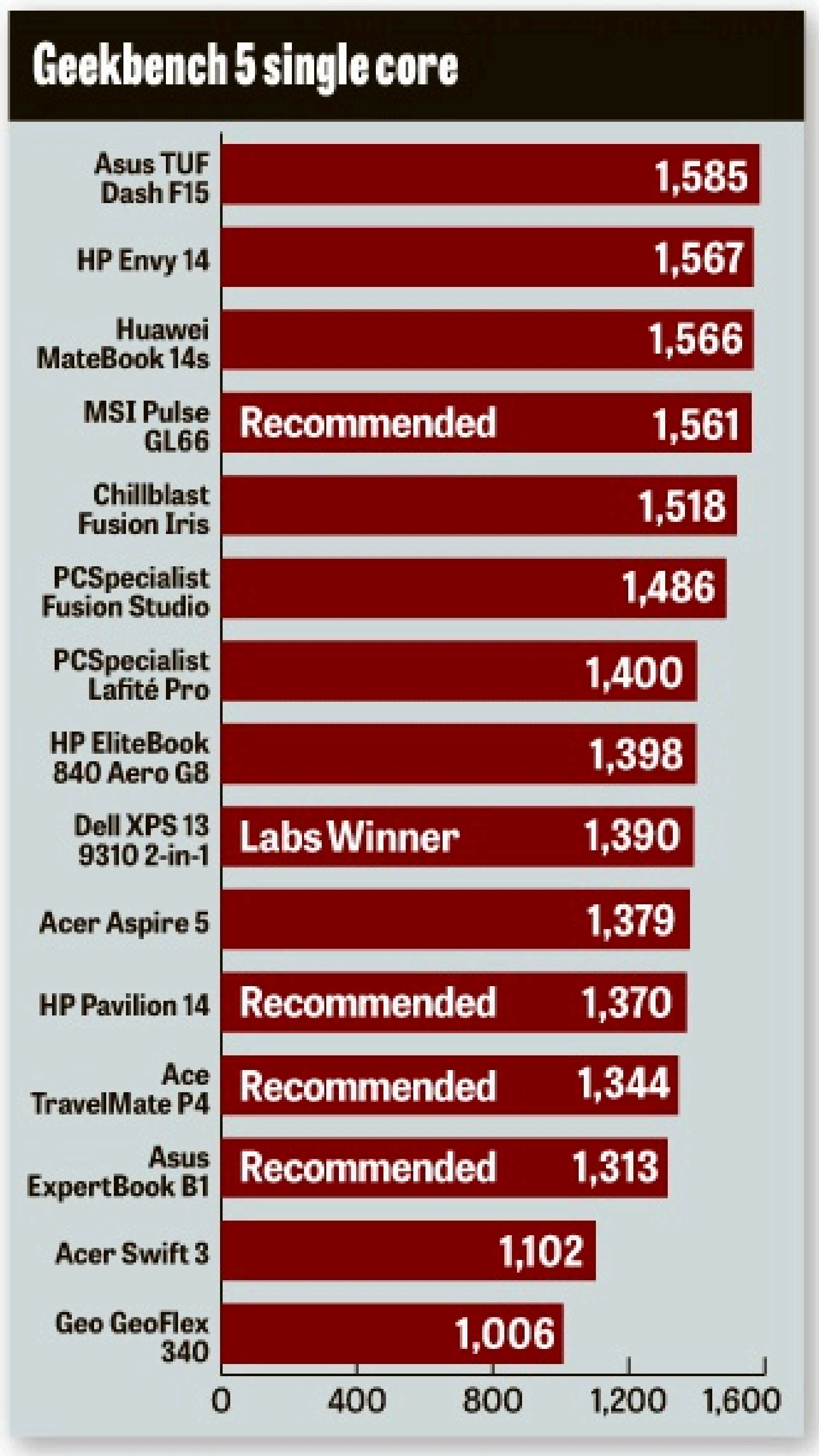
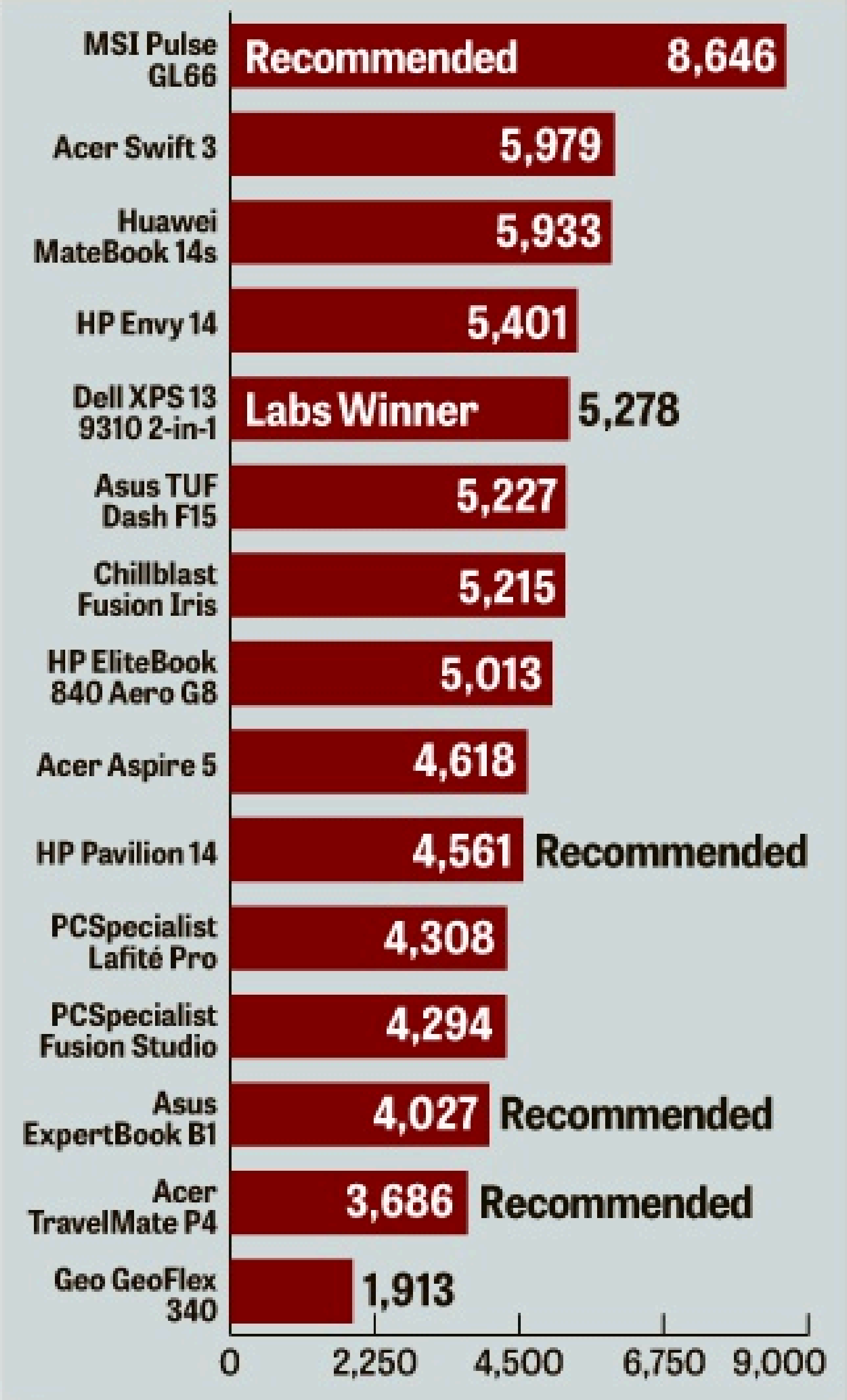
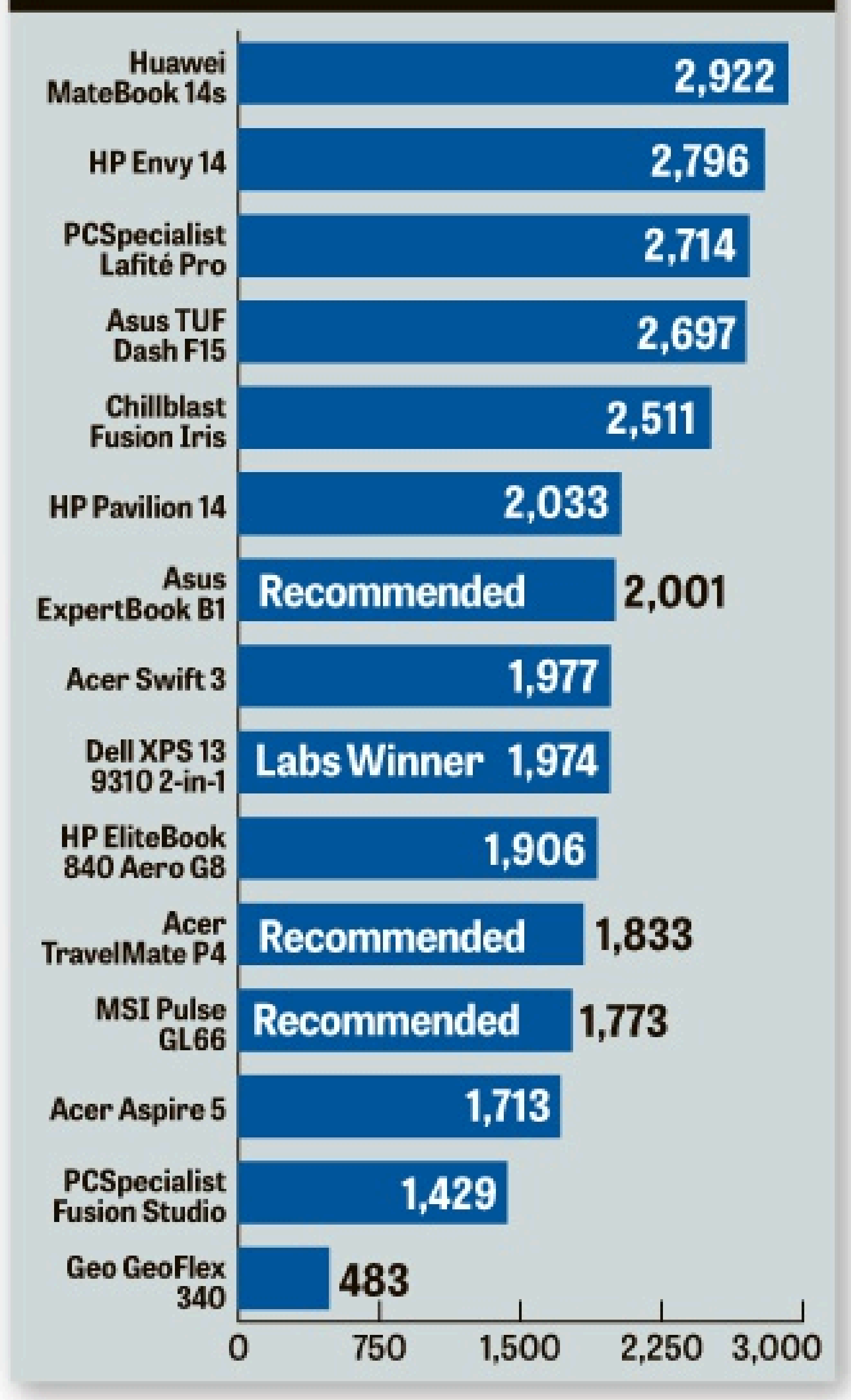
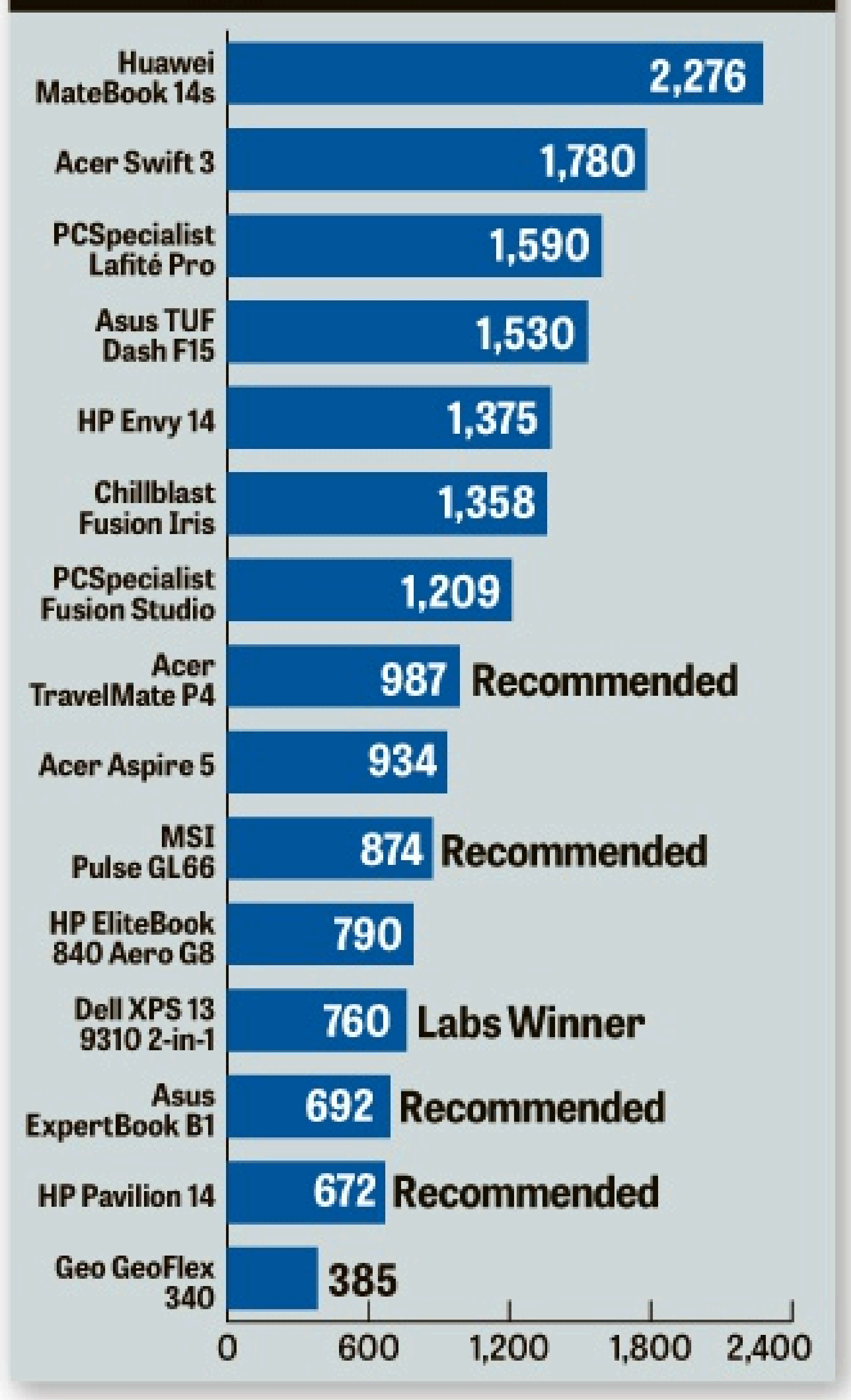

Cinebench R23 multicore

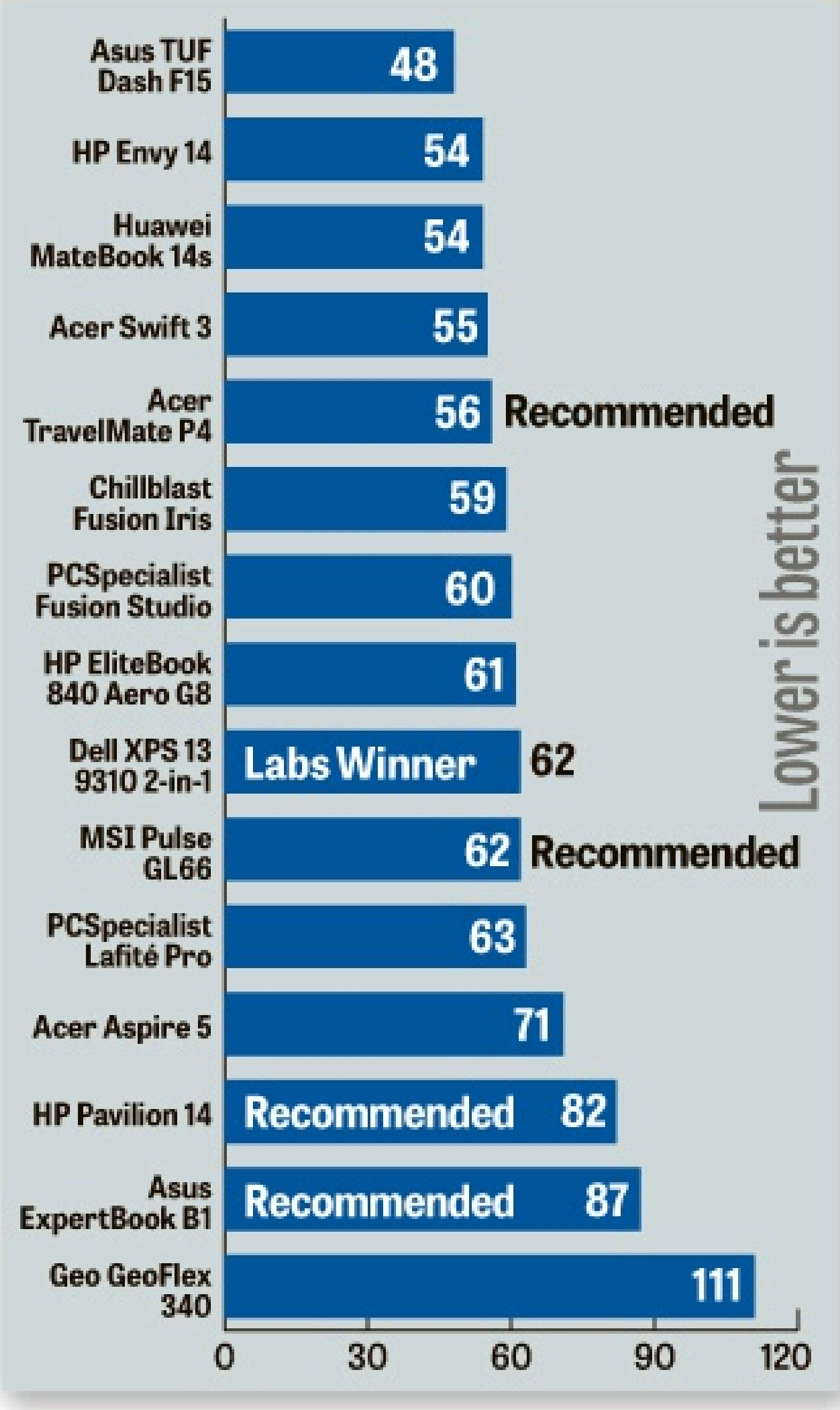

Geekbench 5 single core


Geekbench 5 multicore

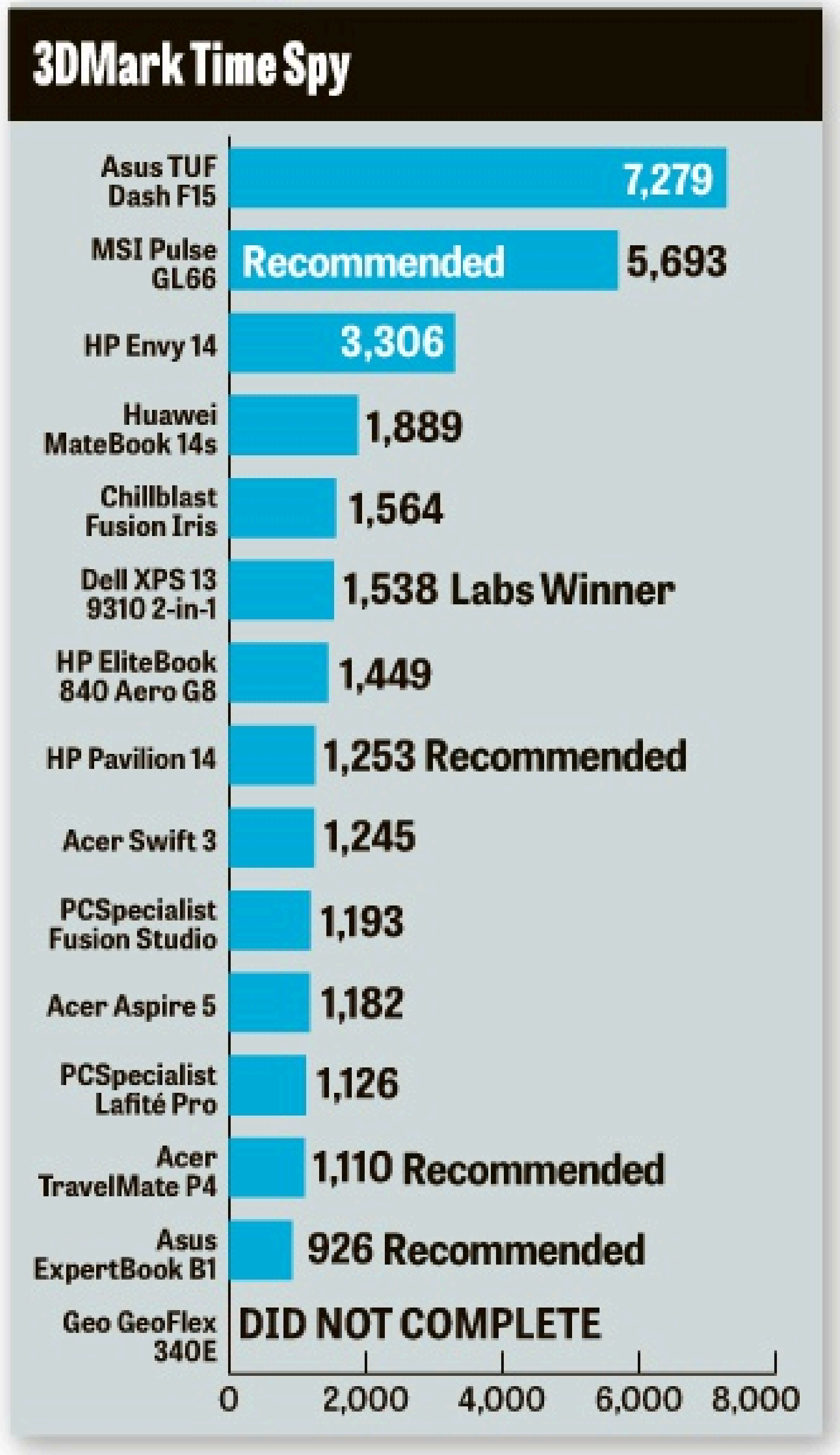
SSD tests

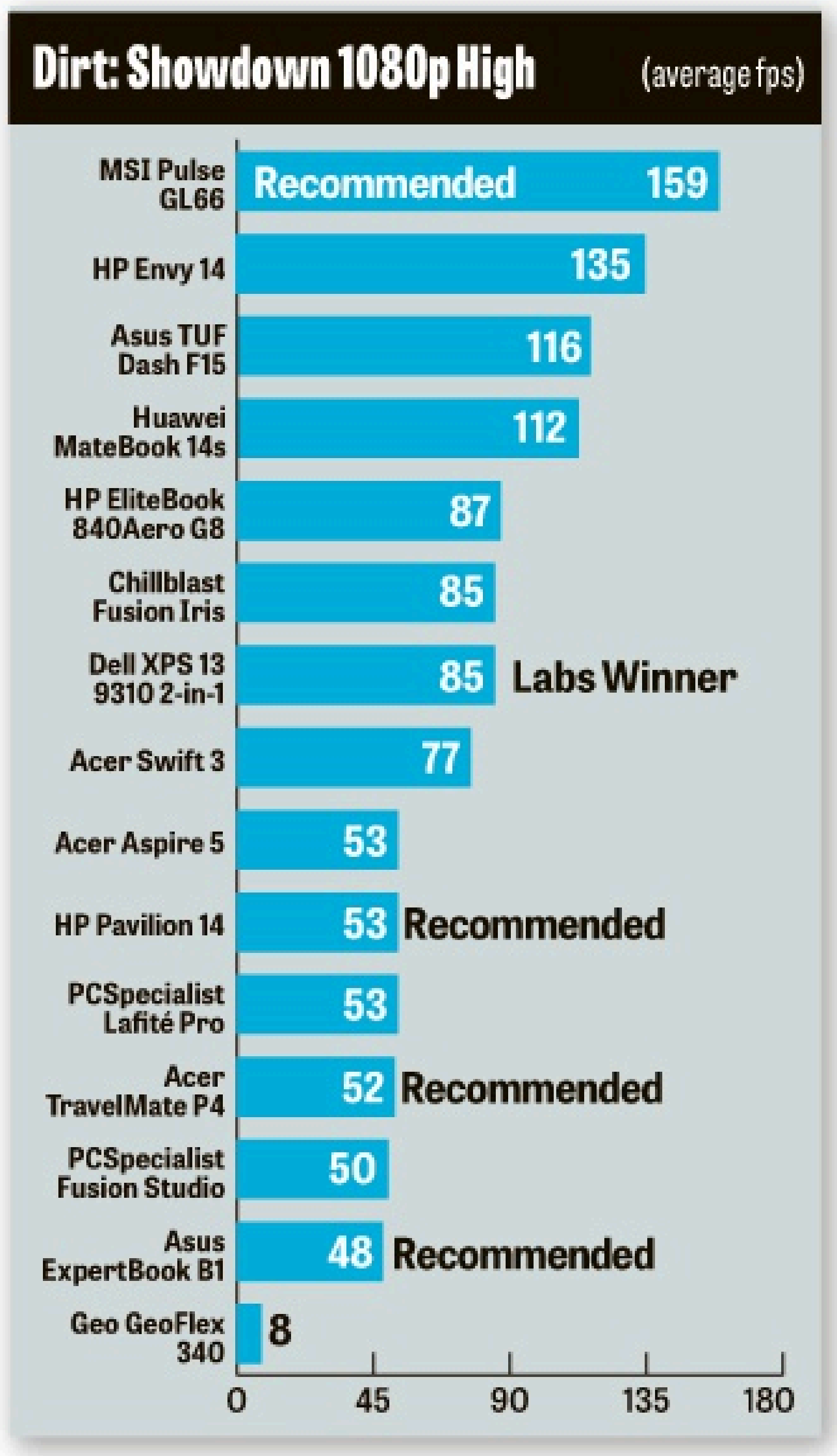

AS SSD sequential read (MB/sec)

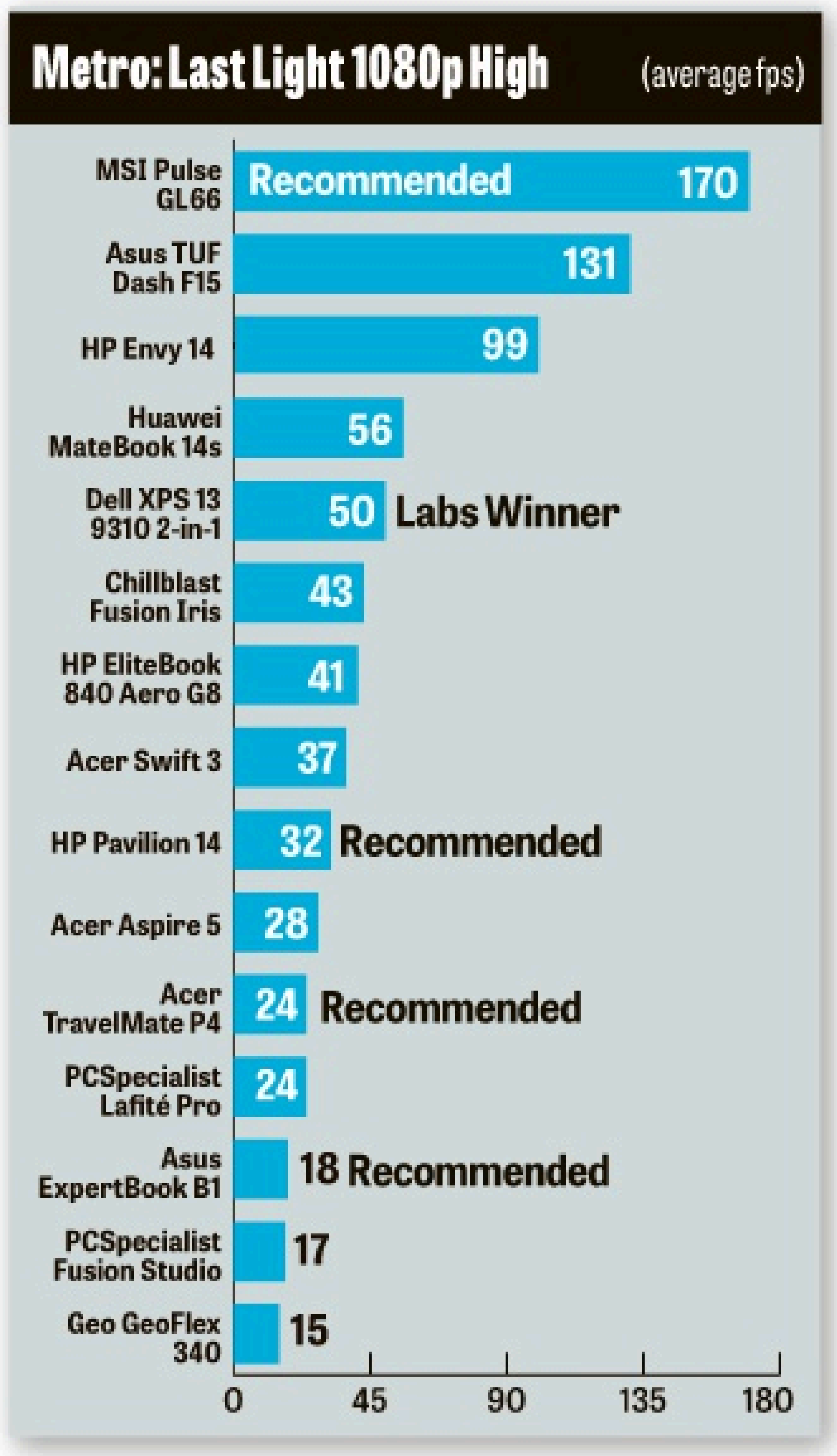

AS SSD sequential write (MB/sec)


Real-world transfer test (11GB, secs)

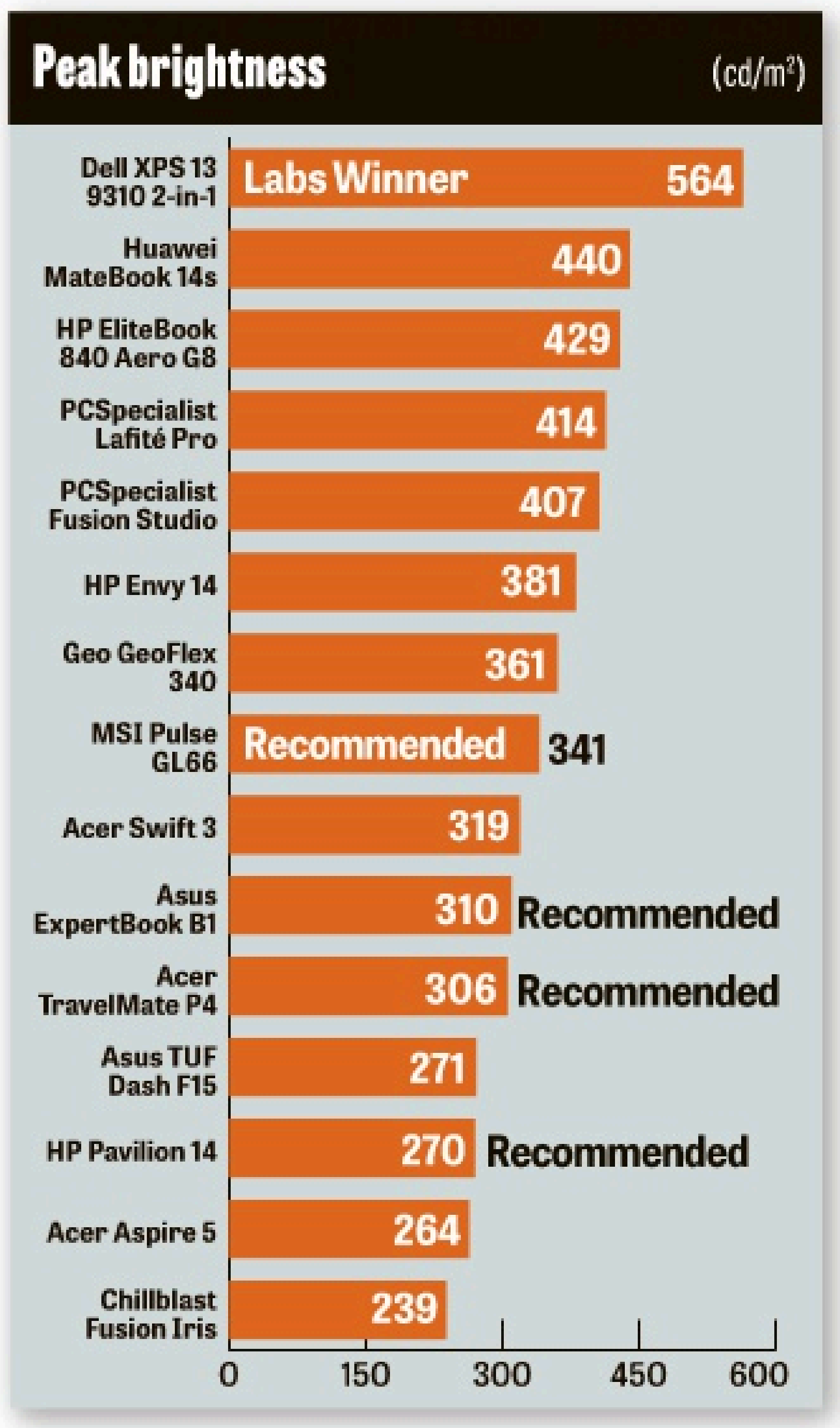
Gaming tests

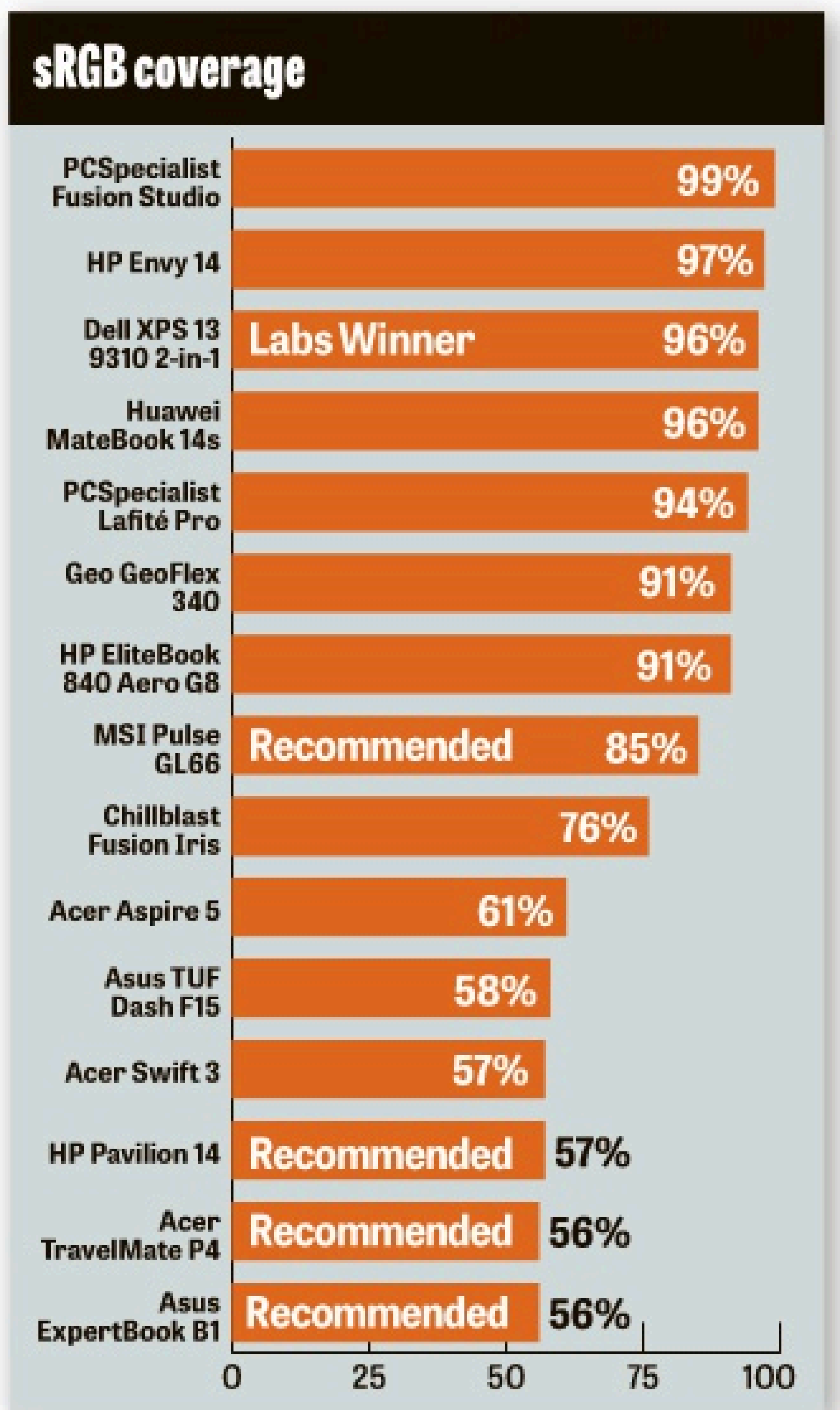


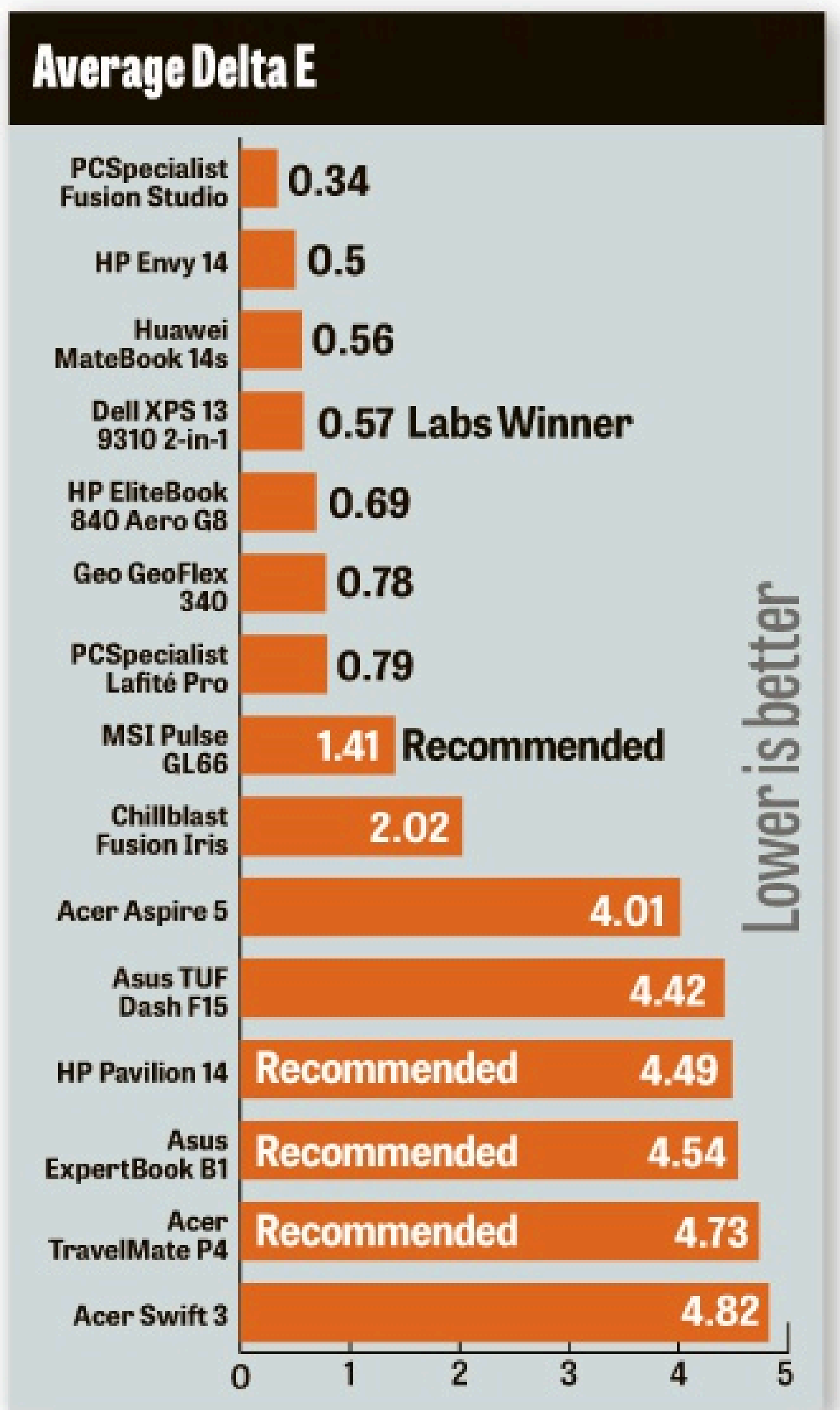




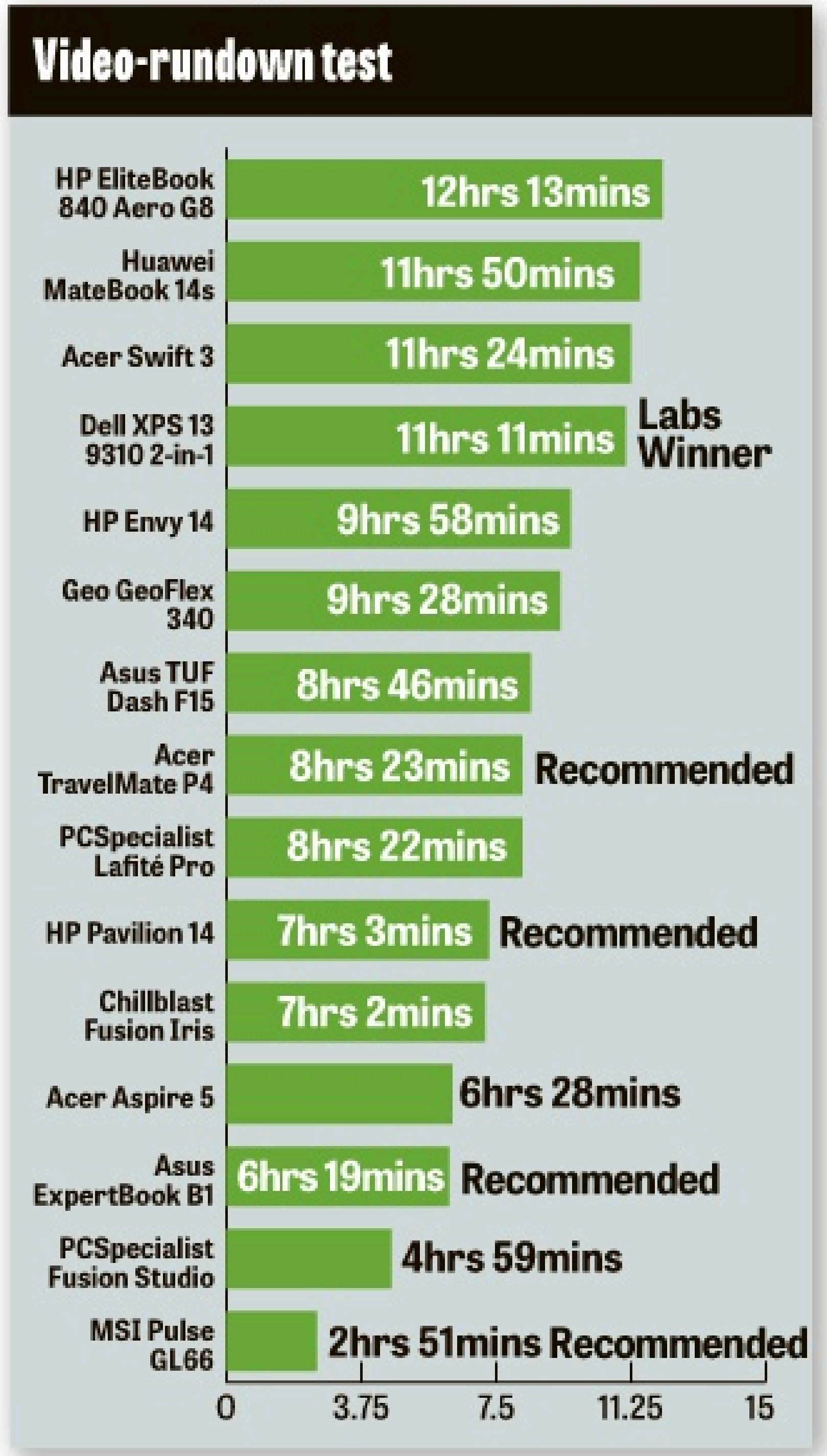
Screen tests

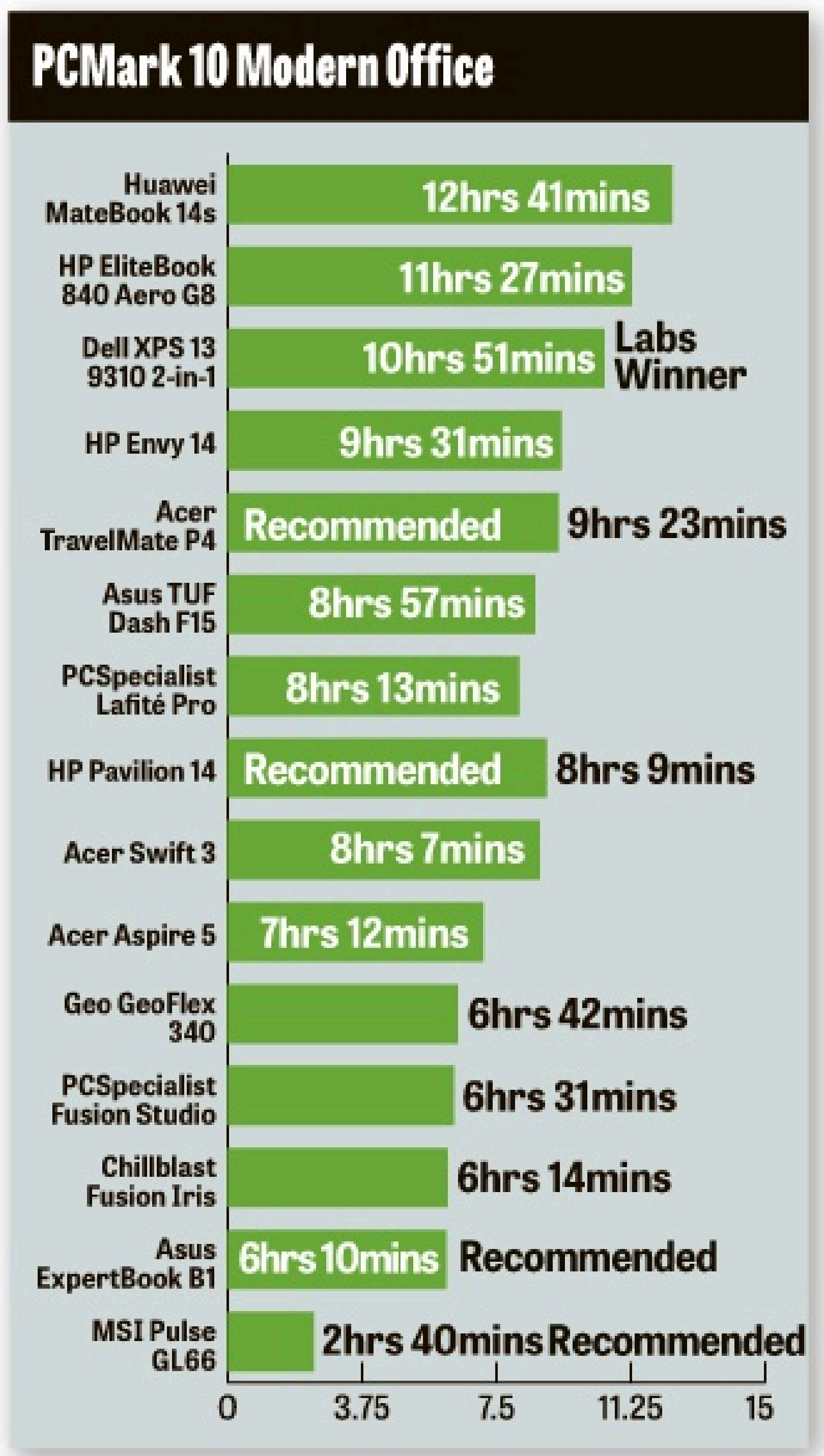


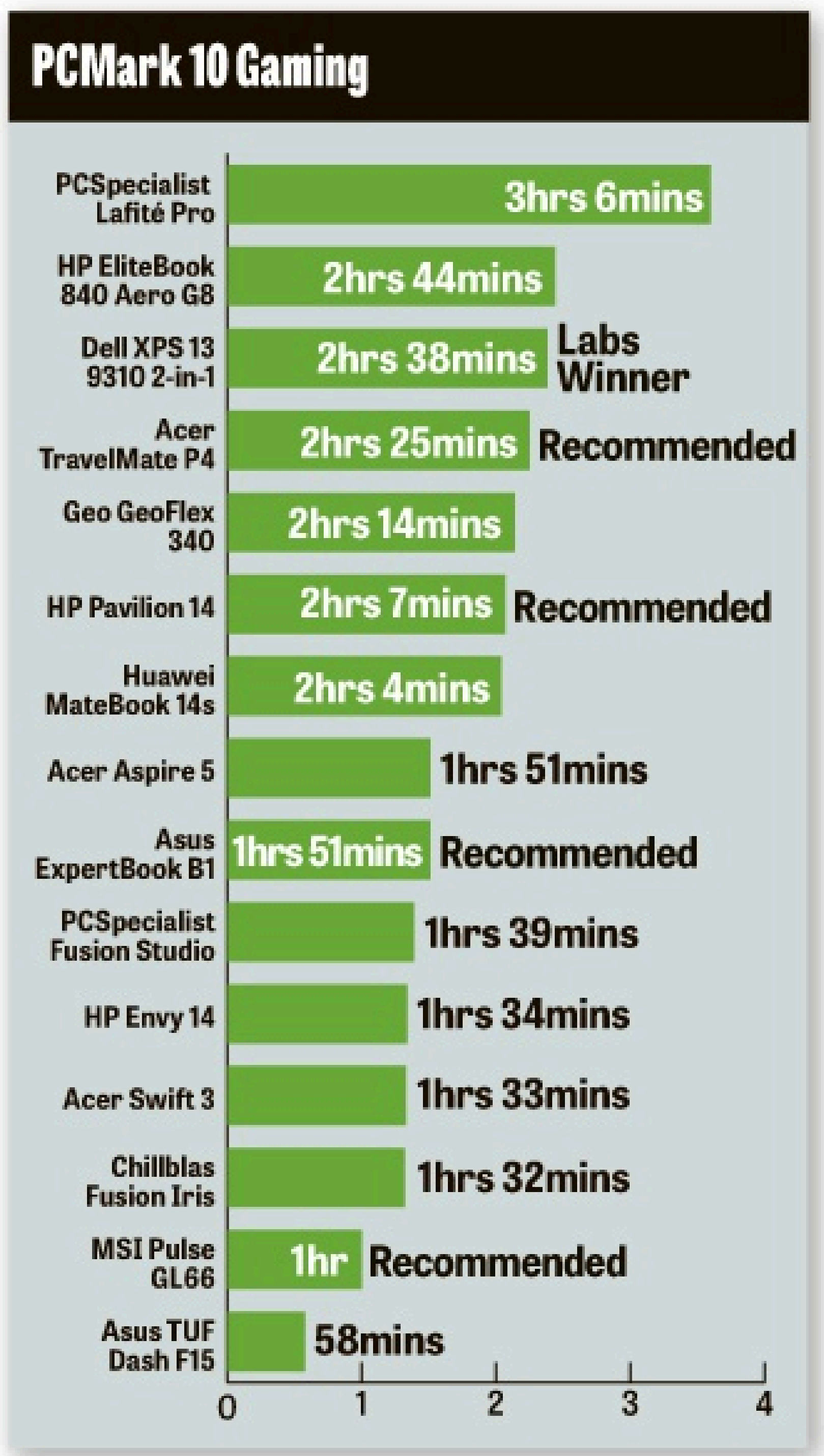




Battery life tests







View from the Labs

Note to self and the industry: we all need to up our game when it comes to webcams built into laptops

I know it's trendy to blame the media, but I also wonder if it's our fault. The woeful state of webcams in laptops, that is. As my mini biography kindly points out at the foot of this column, I've been reviewing laptops for over 20 years – my first in summer 1999, if I recall correctly – but it's only in the past 18 months that I've paid much attention to the quality of their webcams.

Now, obviously people used webcams before the first lockdown, but it was a side issue. They were for family get-togethers over Skype, a very occasional conflab with colleagues who worked on different continents (but wasn't that what boardroom videoconferencing solutions were for?) and those occasional Webex calls where we had to download some weird plugin to make it work.

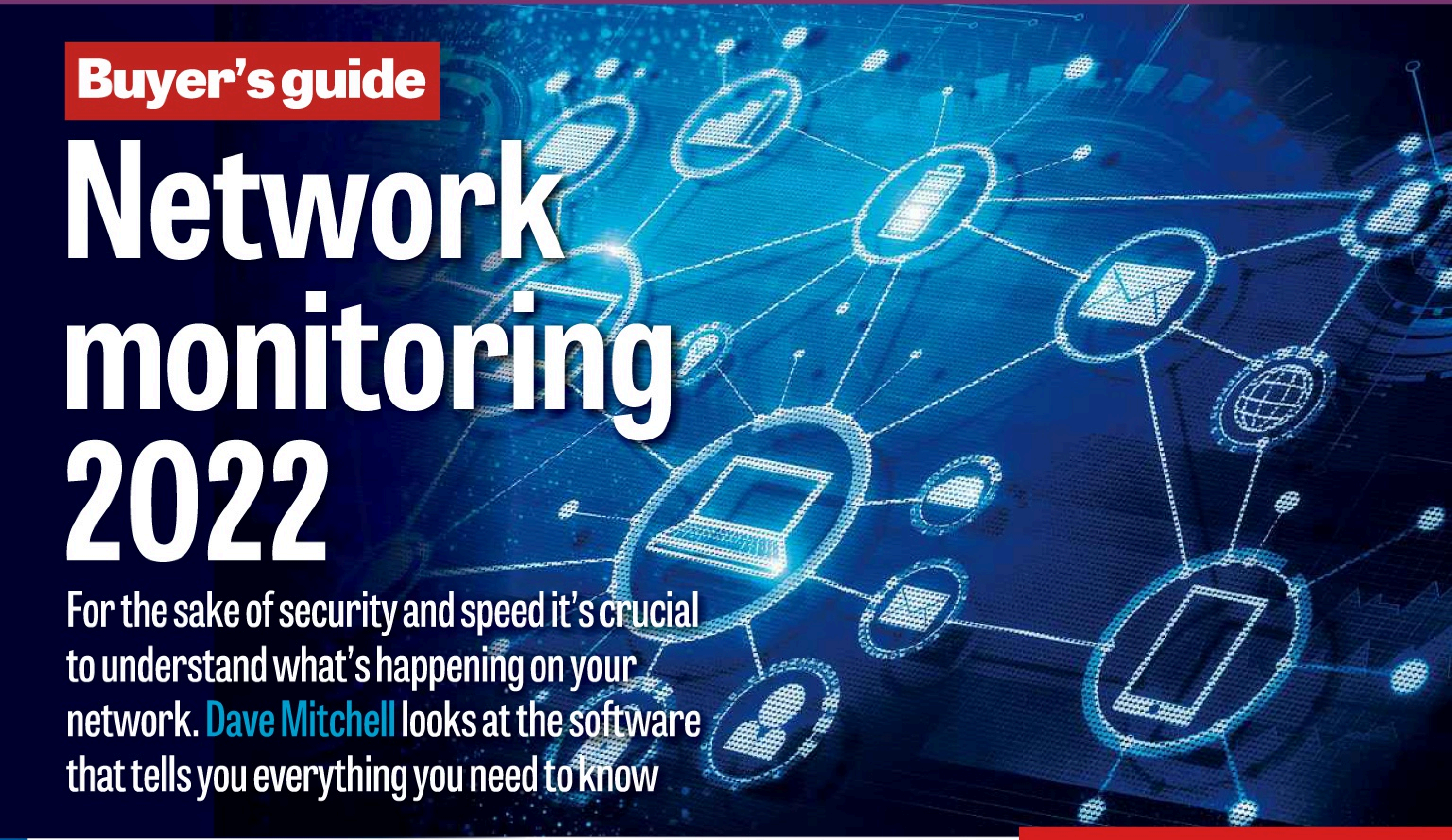
Then Zoom became ubiquitous. Microsoft threw its considerable weight behind Teams. We finally worked out how to make meetings work over Google Meet. In short, software development for group calls went into overdrive, leaving all the hardware for dust. You can almost imagine chaotic scenes in John Lewis where executives fought each other over the last Logitech C920, as if it was the must-have toy for Christmas.

How sad, then, that I'm writing the same things about webcams in 2022 as I was in 2020 and 2021. Fuzzy. Noisy. Poor. I'm hoping, praying, that when the next batch of laptops arrives for testing, my language will have changed; almost as much as I hope that our need for them will have diminished.

Editor-in-chief Tim Danton has been testing laptops for over 20 years. Email editor@pcpro.co.uk

The Network

Practical buying and strategic advice for IT managers and decision makers



Buyer's guide

Network monitoring 2022

For the sake of security and speed it's crucial to understand what's happening on your network. **Dave Mitchell** looks at the software that tells you everything you need to know

The modern IT department has to deal with a growing spread of responsibilities, but one of its core roles remains ensuring the smooth running of the network and associated services. This job isn't getting any easier: networks are constantly growing in size and complexity, and the growth of homeworking adds to the pressure by moving staff out of the office and potentially out of touch.

Network-monitoring software is the ideal solution. It can keep you firmly in control by revealing precisely what's on your network, what it's doing and how smoothly it's performing, as well as promptly alerting you to any potential issues as soon as they emerge.

This isn't something that applies only to enterprises. Such capabilities are just as valuable to SMBs, and the good news is that there are plenty of software solutions to choose from at SMB-friendly prices. This month, we look at four such packages, from Auvik, Paessler, Progress Software and VirtualMetric. They offer a diverse range of monitoring and troubleshooting tools, and on the following pages we put each one through its paces in the lab to help you make the right buying decision.

To cloud or not to cloud?

As is frequently the case, one of the first things to decide is whether you want an on-site or cloud-managed service. An on-site solution is a good choice for SMBs based in a single location as it keeps everything in one place, but you'll need to provide and maintain a host system to run the central components. While most on-premises monitoring products have low hardware requirements, they may require or recommend a Windows Server OS rather than a regular desktop edition of Windows .

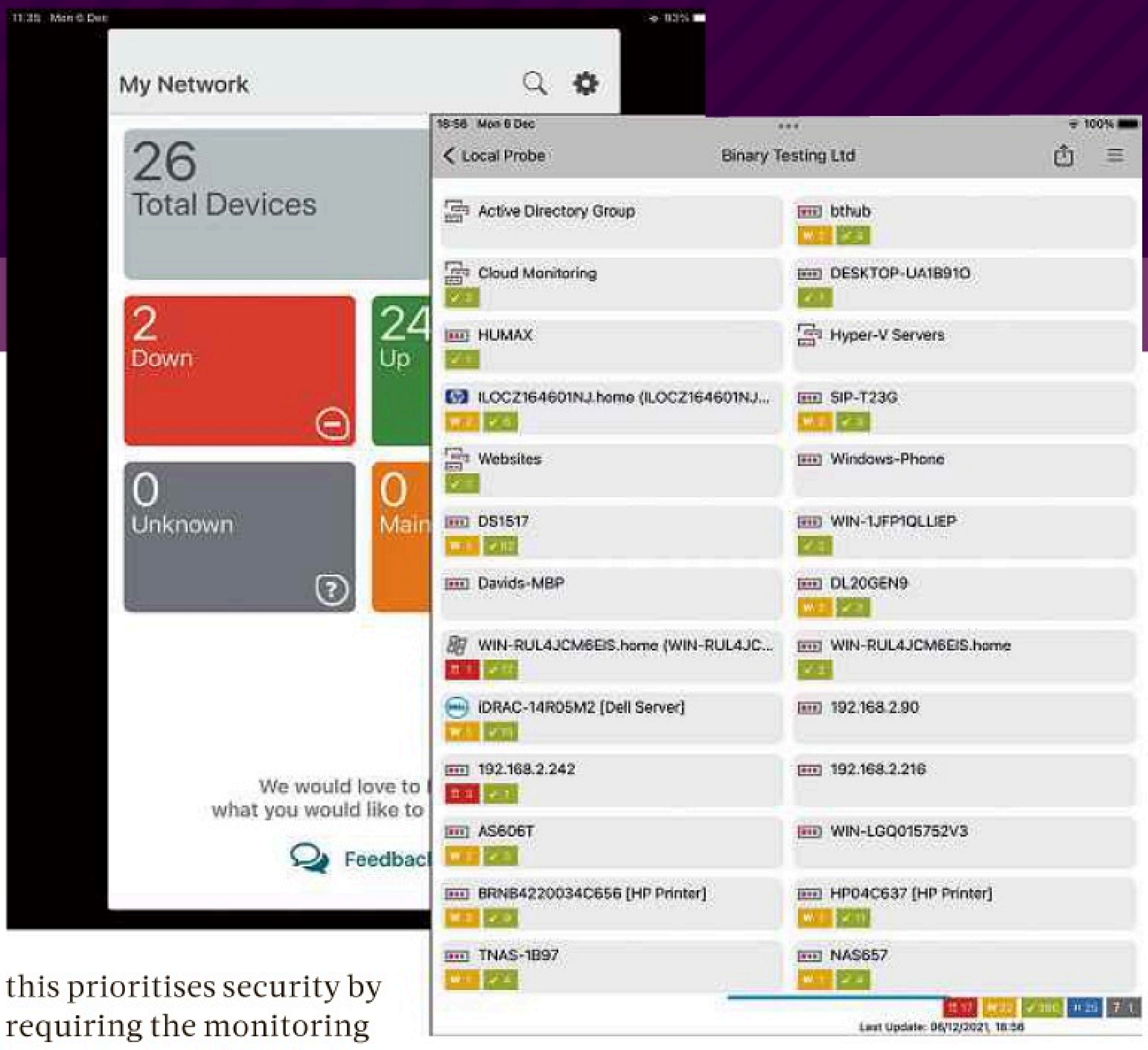
Cloud-hosted solutions work best for businesses with geographically distributed offices, as support staff can keep an eye on any number of sites from a single portal. You'll normally still need a host system on each local network, though; this is required to collect device information and pass it on (in a safely encrypted form) to the cloud servers.

> **"The software will scan the network and identify all connected clients, rather than staff having to register them manually"**

What's on your network?

Network discovery is a basic function of network-monitoring software. This simply means that the software will scan the local network and identify all connected clients for itself, rather than your staff having to register their addresses manually. This can save you a lot of time during initial setup, and ensures that nothing gets overlooked: you might be surprised by just how many devices the scan turns up. Thereafter, you can run regular automatic discoveries to pick up anything that's subsequently added to the network.

If you only want to carry out a basic inventory of connected clients then you don't need to do anything further, but to collect more detailed information each device must be configured correctly. Infrastructure devices such as switches, routers and firewalls require the simple network management protocol (SNMP) service to be enabled; where available, you should use the SNMPv3 standard, as


My Network
26
Total Devices
2
Down
24
Up
0
Unknown
0
Main
We would love to
what you would like to
Feedback
Local Probe
Binary Testing Ltd
Active Directory Group
bthub
Cloud Monitoring
DESKTOP-UA1B910
HUMAX
Hyper-V Servers
ILOCZ164601NJ.home (ILOCZ164601NJ...
SIP-T23G
Websites
Windows-Phone
DS1517
WIN-1JFP1QLLIEP
Davids-MBP
DL20GEN9
WIN-RUL4JCM6EIS.home (WIN-RUL4JC...
WIN-RUL4JCM6EIS.home
iDRAC-14R05M2 [Dell Server]
192.168.2.90
192.168.2.242
192.168.2.216
AS606T
WIN-LGQ015752V3
BRN84220034C656 [HP Printer]
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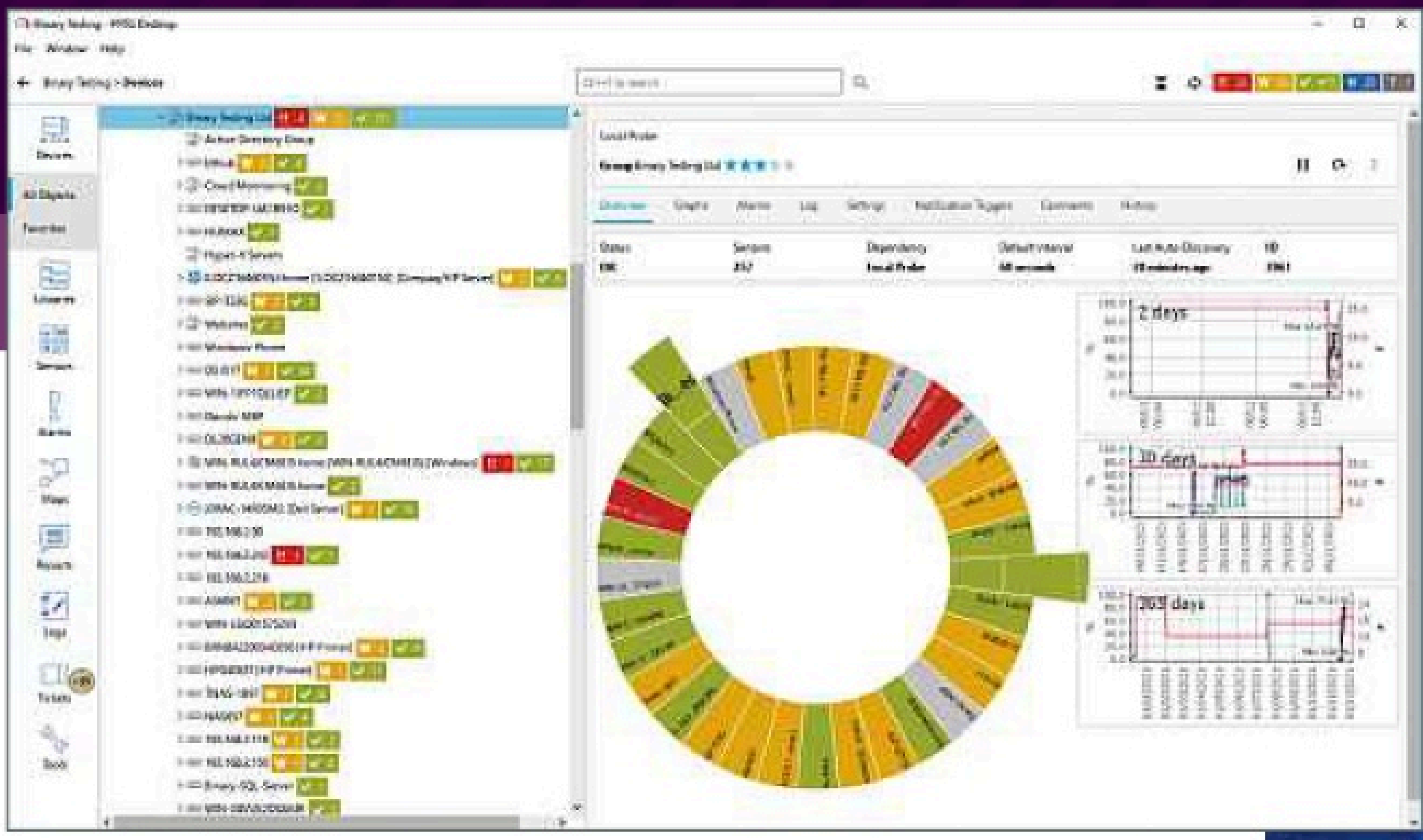
NAS657
Last Update: 06/12/2021, 18:56



ABOVE PRTG's desktop app grabs monitoring data from its server to show the big picture

LEFT Free mobile apps let you monitor on the move

this prioritises security by requiring the monitoring software to authenticate before allowing access.

For Windows systems, the preferred monitoring method is via the Windows Management Instrumentation (WMI) service. This is enabled by default and provides a lot more system information than SNMP, including details of running services, processes, storage usage and Hyper-V sessions.

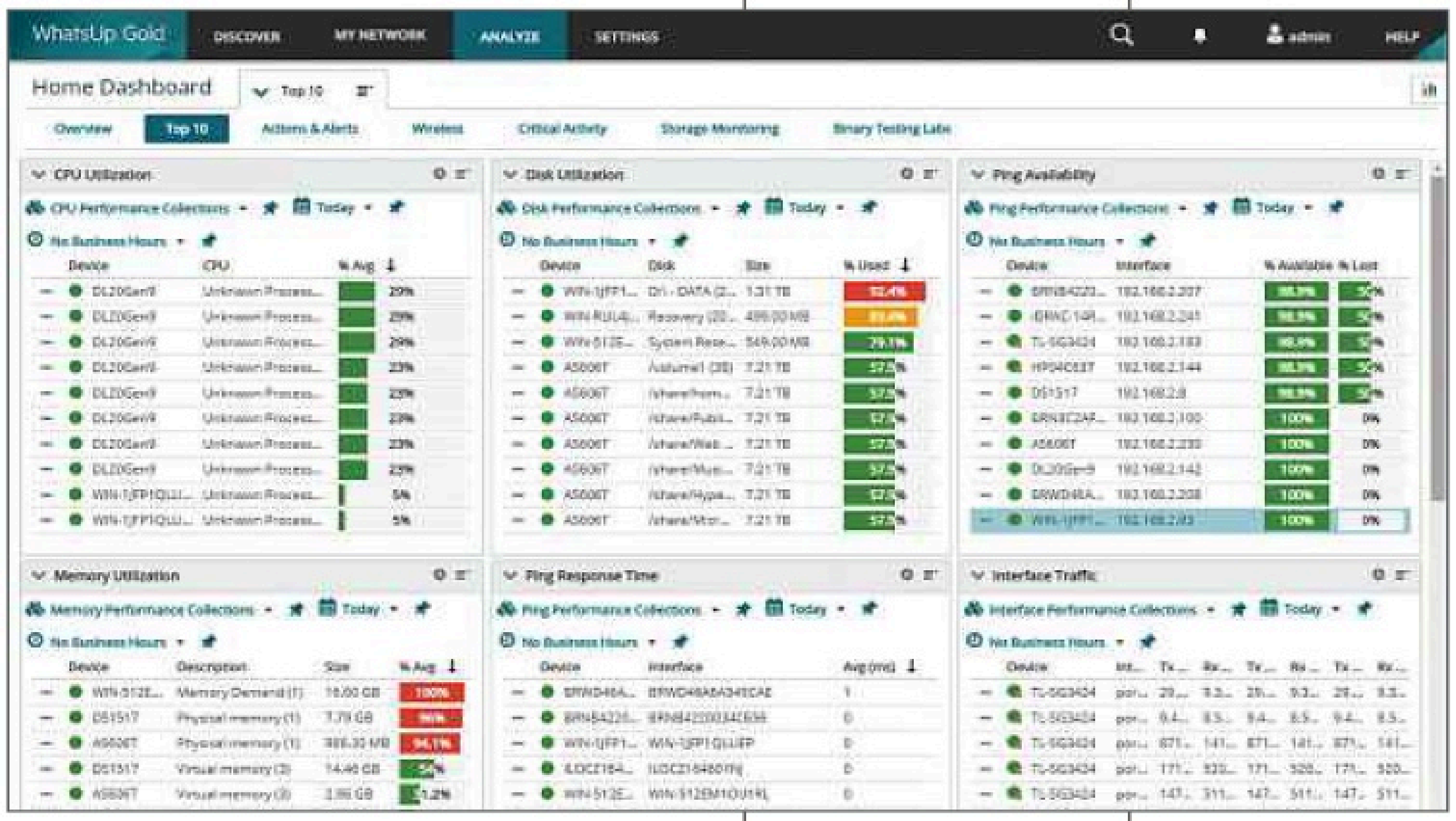
Since the monitoring software needs to store high-level device credentials to gather information, make sure you use the built-in access controls to prevent unauthorised usage. Ideally, choose a product that allows you to assign different roles to different users, so that low-level support staff can access functions such as viewing and reporting, while password management is restricted to trusted individuals.

App monitoring

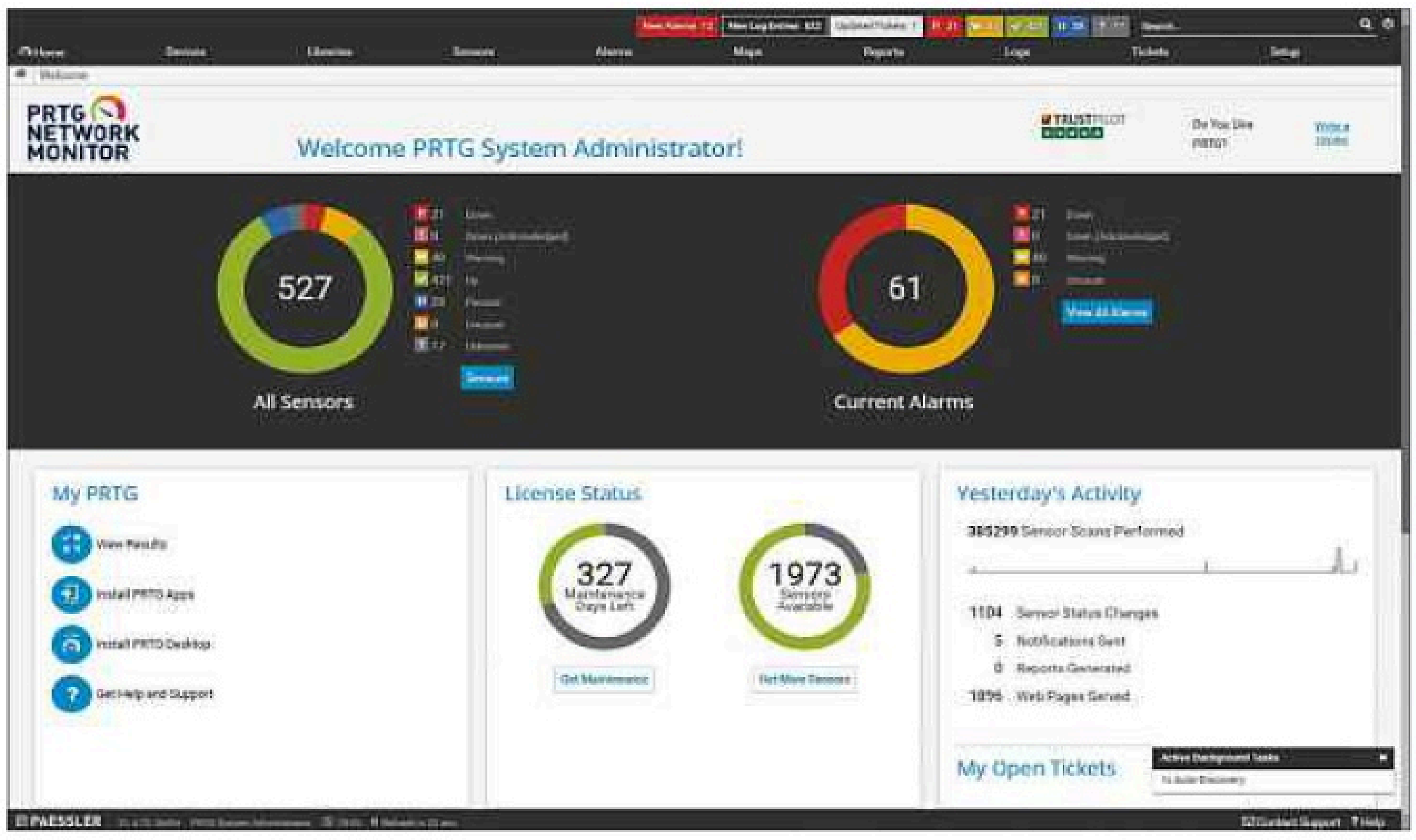
Along with device and service status monitoring, many products can keep a close eye on business apps such as Exchange, IIS and SQL Server – and even cloud services like Amazon AWS and Microsoft 365. If you want to make use of these capabilities, check the small print: some packages only provide these facilities as optional, chargeable features or add-on modules.

In fact you may not need to monitor your applications directly. A huge amount of valuable information can be gleaned from business-class firewalls and routers that generate Syslog and flow data. The latter in particular can reveal all sorts of things about application usage, and monitoring products are often able to analyse such flow data and present their findings in easy-to-read tables and graphs.

It's also worth doing a little research if you want to access your network-monitoring solution on the move. Mobile support varies hugely across products; only two of the four vendors in this guide offer free Android and iOS apps, and frankly only one of them is any good.


WhatsUp Gold
DISCOVER
MY NETWORK
ANALYZE
SETTINGS
Home Dashboard
Top 10
CPU Utilization
Disk Utilization
Ping Availability
Memory Utilization
Ping Response Time
Interface Traffic

ABOVE The WhatsUp Gold dashboard shows a handy list of "Top 10" statistics


PRTG NETWORK MONITOR
Welcome PRTG System Administrator!
527
All Sensors
61
Current Alarms
My PRTG
License Status
327
1973
Yesterday's Activity
My Open Tickets

BELOW If you run out of sensors, they can be quickly deleted and reassigned

It's elementary

One of the most perplexing issues in the network-monitoring market is licensing. Products may be licensed according to the number of monitored elements, sensors or devices, and no two vendors use quite the same scheme.

Thankfully, the jargon isn't hard to understand. The terms "element" and "sensor" each refer to a single monitored item, which might be one CPU core, one Windows service, one disk volume or one port on an Ethernet switch. By contrast, a "device" covers all connectors and activities on a single device, regardless of the number of components it has.

Clearly, it's worth working out exactly what you want to monitor before investing, as this can have a big effect on your cost calculations. Per-device licensing is simple and powerful, but it can easily get expensive. Sensor licences tend to be much more cost-effective, but you need to take a more targeted approach with your monitoring, and even then your allocation can get used up very quickly. Choose a product that lets you move sensors around, so you can easily reassign them to wherever they're needed.

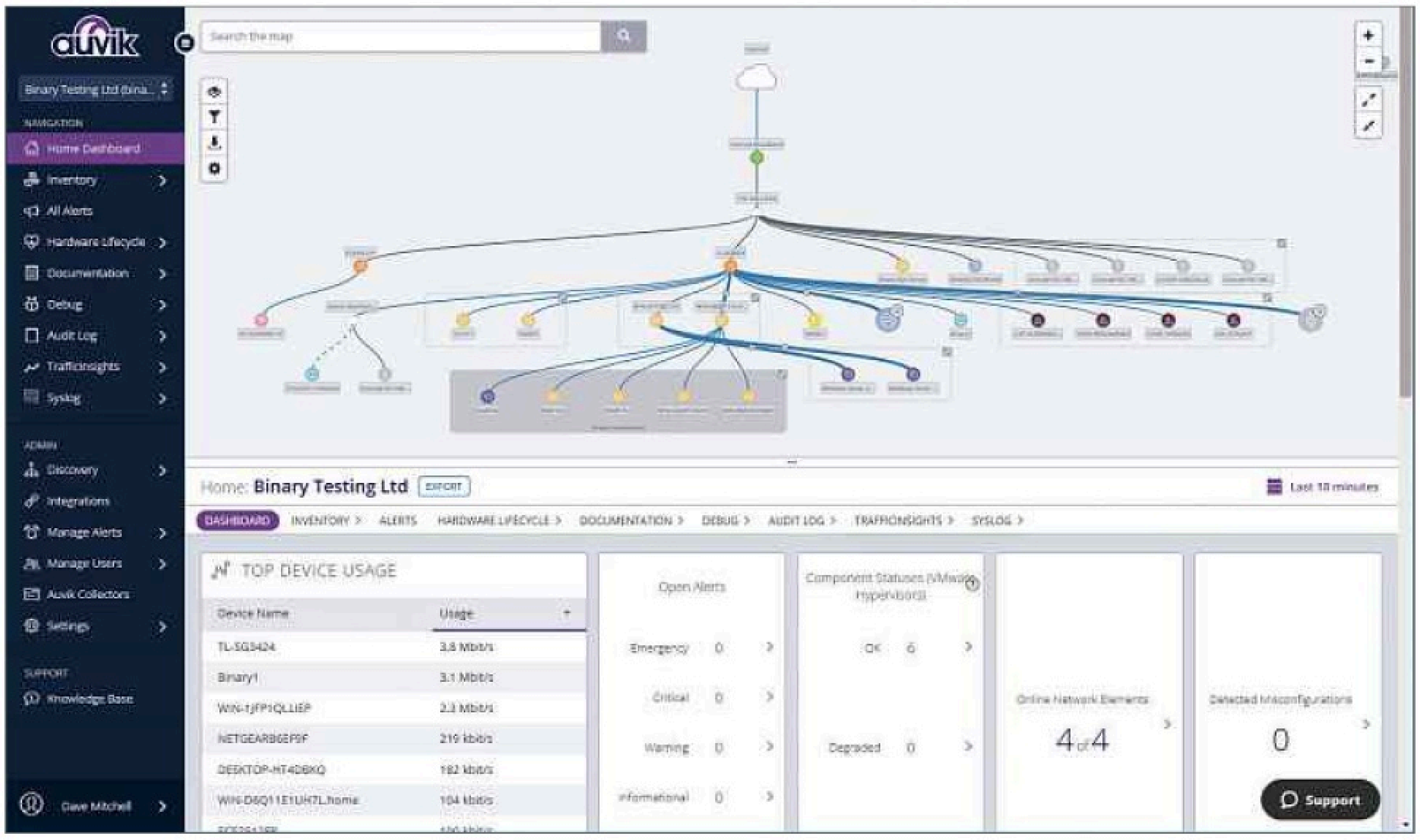
To help you work out which product works for you, we've chosen four products for this month's Buyer's Guide that all offer free time-limited evaluations. Read on to see which one will help keep your business network running like a well-oiled machine.

Auvik Network Management

A breeze to deploy, Auvik's cloud-hosted monitoring is quick to provide a complete picture of your network

SCORE ★★★★☆

PRICE **Essentials, 25 devices, £375 per month exc VAT from auvik.com**


auvik
Binary Testing Ltd (bina...
NAVIGATION
Home Dashboard
Inventory
All Alerts
Hardware Lifecycle
Documentation
Debug
Audit Log
TrafficInsights
Syslog
ADMIN
Discovery
Integrations
Manage Alerts
Manage Users
Auvik Collectors
Settings
SUPPORT
Knowledge Base
Dave Mitchell
Search the map
Home: Binary Testing Ltd
EXPORT
Last 10 minutes
DASHBOARD
INVENTORY
ALERTS
HARDWARE LIFECYCLE
DOCUMENTATION
DEBUG
AUDIT LOG
TRAFFICINSIGHTS
SYSLOG
TOP DEVICE USAGE
Open Alerts
Component Statuses (VMware Hypervisors)
Online Network Elements
Detected Misconfigurations
Support

Device Name	Usage
TL-SG3424	3.8 Mbit/s
Binary1	3.1 Mbit/s
WIN-1JFP1QLLIEP	2.3 Mbit/s
NETGEARB6EF9F	219 kbit/s
DESKTOP-HT4DBKQ	182 kbit/s
WIN-D6Q11E1UH7L.home	104 kbit/s

Open Alerts	
Emergency	0
Critical	0
Warning	0
Informational	0

Component Statuses (VMware Hypervisors)	
OK	6
Degraded	0

Online Network Elements: 4 of 4

Detected Misconfigurations: 0

ABOVE **Auvik's discovery is lightning quick and provides a smart dynamic map**

There are plenty of cloud-hosted network-monitoring options to choose from, but Auvik can claim to be one of the fastest to deploy. Two versions are available: the Essentials edition provides network mapping, monitoring, alerting and device configuration management, while the Performance edition adds features such as Syslog collection and flow data analysis for detailed application visibility.

To use it you simply need to install a collector agent in each site – and this is painless as it's a lightweight service that will run on any version of Windows. The back-end, meanwhile, is hosted in AWS data centres, and protected by both single sign-on and 2FA procedures. All collector data is encrypted, and outbound communications are only permitted with its cloud servers.

Onboarding is a piece of cake. After creating our cloud account we used Microsoft's Authenticator app to confirm secure administrative access, created our first site and downloaded the agent installer. After running this on a Windows Server 2019 host, we were prompted to provide a unique API key, and then a secure connection to our cloud account was created.

Auvik kicks off its discovery process immediately, and while it's scanning you can enter credentials for SNMP, WMI, SSH, telnet and VMware. We were impressed to see that it took only around 16 minutes to build a fully populated network map for a complete subnet.

From now on the network is continuously scanned – you can set an interval in seconds – while the map shows your network layout. Coloured link lines between devices distinguish between Layer 1, Layer 3 and VPN connections, while dotted lines denote wireless links. We found the map quickly updated itself to reflect network or device state changes, and each device icon is active, so you can hover over a node to see a pop-up status window, or click to load its details in the panel below.

The home dashboard panel provides a handy activity overview with tables of the busiest devices, open alerts, SSL VPN status and the condition of VMware host hardware components. The software offered full visibility into our Hyper-V host, showing details such as CPU, memory, storage and virtual switch utilisation, traffic throughput and individual VM status.

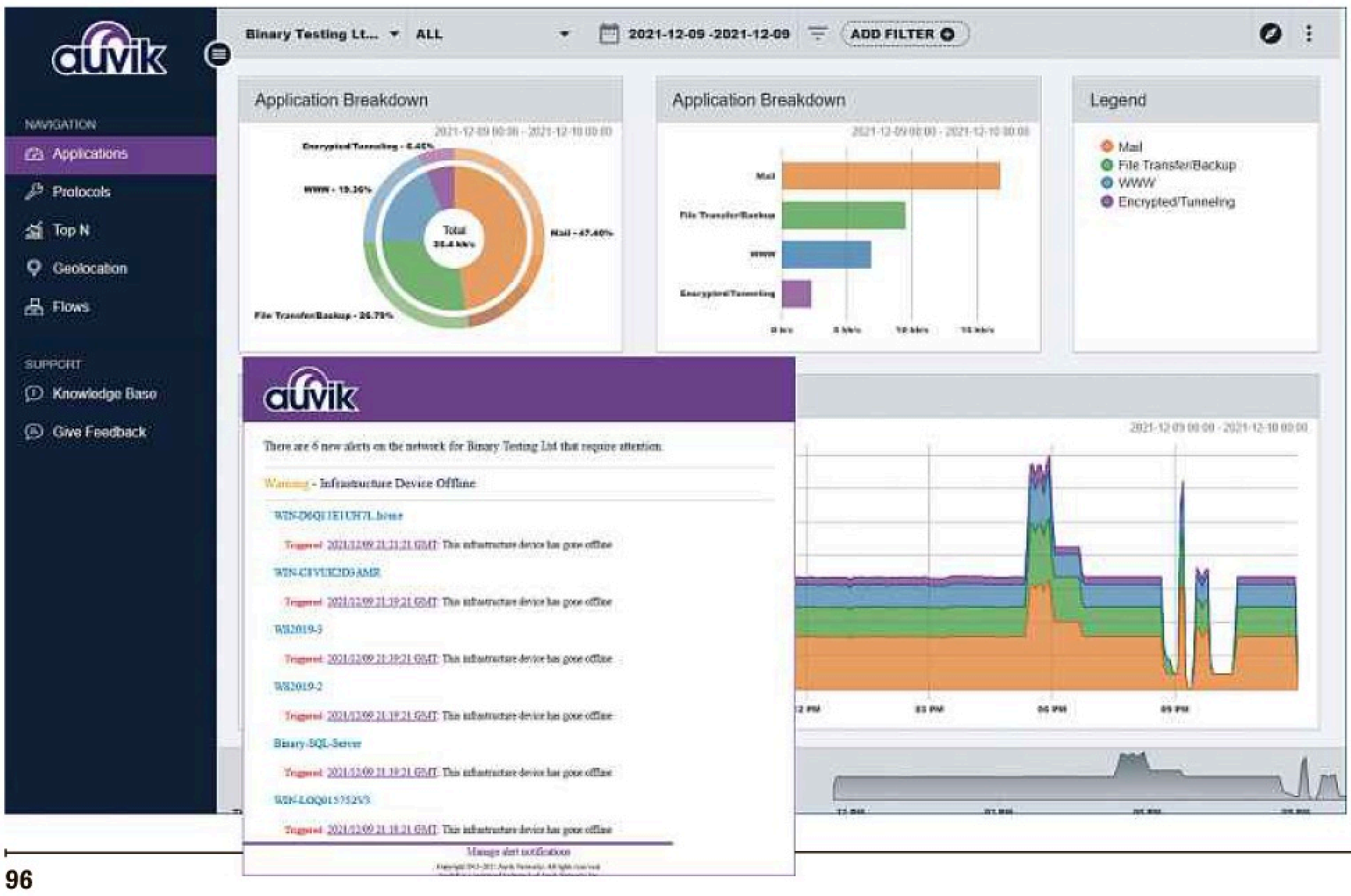
To help you keep on top of any emergent issues, Auvik provides 58 preconfigured alerts, ranging from a down device or service to high storage usage, as well as the option to set your own. Notifications can be sent by email or via various messaging platforms, including Teams, Slack and FreshDesk.

PC PRO RECOMMENDED

> **"Notifications can be sent by email or various messaging platforms, including Teams, Slack and FreshDesk"**

While Auvik's main focus is clearly on network, service and device availability, it can also keep critical infrastructure devices safe with automated configuration backups, restores and comparisons. The Performance edition adds a TrafficInsights dashboard where NetFlow, sFlow and J-Flow data is ingested, analysed and presented as very informative graphs.

Auvik's per-device licensing initially looks expensive, but it's not hard to customise the configuration so that only your important devices are monitored, and you save by not having to provide a dedicated on-premises host. Since it's so versatile, so easy to deploy and so simple to manage, it's a good choice for SMBs that want a clear picture of their network.


auvik
NAVIGATION
Applications
Protocols
Top N
Geolocation
Flows
SUPPORT
Knowledge Base
Give Feedback
Binary Testing Lt...
ALL
2021-12-09 -2021-12-09
ADD FILTER
Application Breakdown
Encrypted/Tunneling - 6.45%
WWW - 19.36%
Total
Mail - 47.40%
File Transfer/Backup - 26.79%
Application Breakdown
Mail
File Transfer/Backup
WWW
Encrypted/Tunneling
Legend
Mail
File Transfer/Backup
WWW
Encrypted/Tunneling
2 PM
03 PM
06 PM
09 PM
auvik

There are 6 new alerts on the network for Binary Testing Ltd that require attention.

Warning - Infrastructure Device Offline

WIN-D6Q11E1UH7L.home

Triggered: 2021/12/09 21:21:21 GMT: This infrastructure device has gone offline

WIN-C8VUK2D9AMR

Triggered: 2021/12/09 21:19:21 GMT: This infrastructure device has gone offline

WS2019-3

Triggered: 2021/12/09 21:19:21 GMT: This infrastructure device has gone offline

WS2019-2

Triggered: 2021/12/09 21:19:21 GMT: This infrastructure device has gone offline

Binary-SQL-Server

Triggered: 2021/12/09 21:19:21 GMT: This infrastructure device has gone offline

WIN-LOQ01575295

Triggered: 2021/12/09 21:19:21 GMT: This infrastructure device has gone offline

Manage alert notifications

BELOW **Auvik's alerting features are extensive and fully customisable**

REQUIREMENTS
Collector supports Windows 7/Server 2012 R2 upwards, VMware, Oracle VirtualBox, Ubuntu Linux

OPTIONS Auvik Performance, 25 devices: £500 per month exc VAT

Paessler PRTG Network Monitor 21.4

This affordable and versatile monitoring solution suits all types of networks with a sensor for every occasion

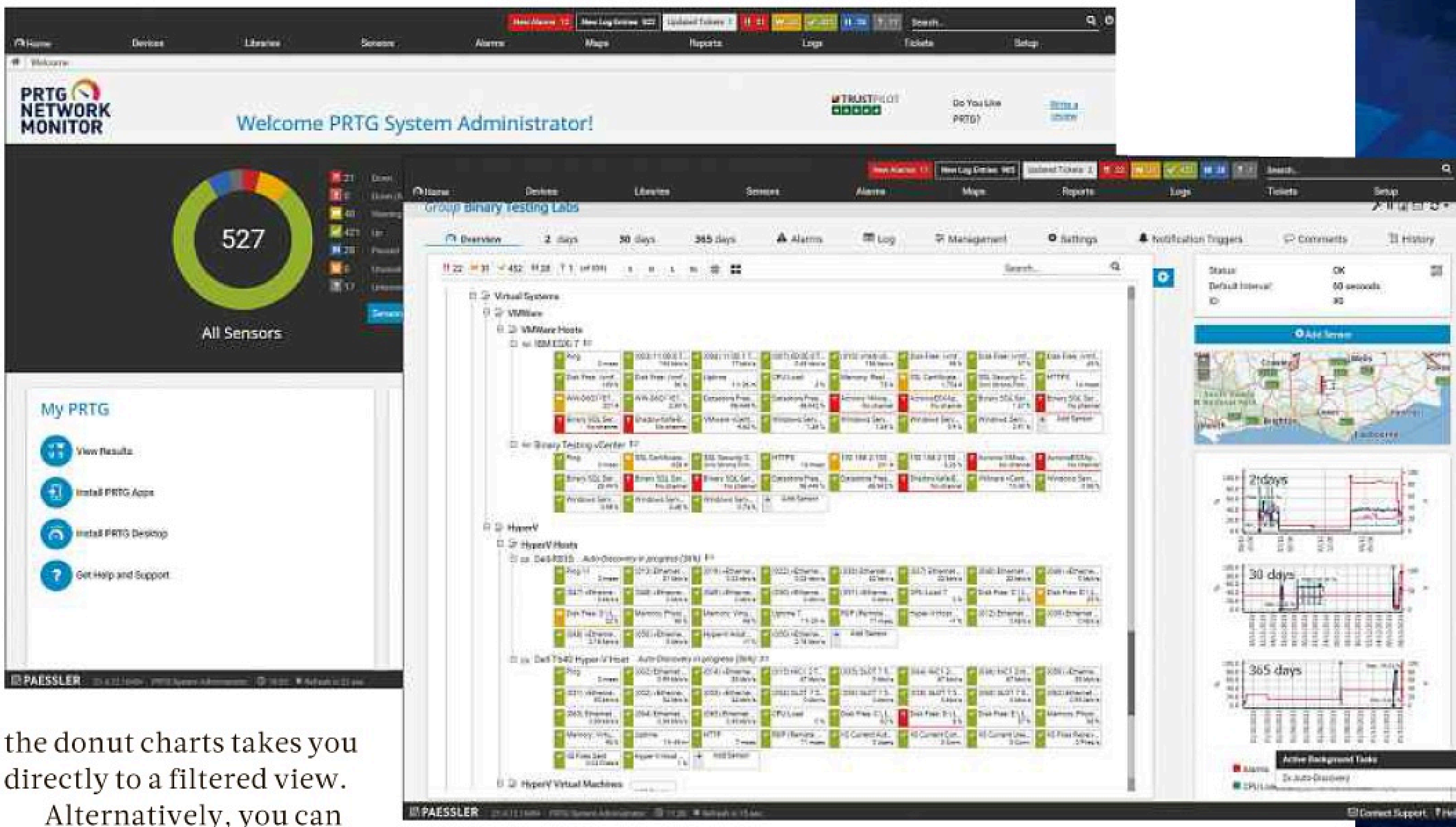
SCORE ★★★★★

PRICE 2,500 sensors, 1yr maintenance, €4,950 exc VAT from paessler.com

If you're feeling bamboozled by complicated licensing models, PRTG Network Monitor is the answer. Pricing is based purely on the number of sensors you want to use – and you don't have to worry about add-ons and extras, as the entire range of 285 different sensor types is included as standard. These cover virtually every type of network device, hardware component, business app and service, so you'd be hard pushed to find something on your network that PRTG couldn't monitor. It's reasonably priced, too, with the Small Business package starting at €1,500 a year for 500 sensors – enough to monitor around 50 devices.

Installation is simple. After we'd loaded PRTG's on-site server software onto a Windows Server 2019 system, a wizard guided us through our first network discovery. This took a slightly leisurely 45 minutes, but PRTG relieved us of a lot of legwork by automatically assigning a suitable set of sensors to each detected device on the network, along with preset thresholds for triggering alerts.

Once you're set up you can access PRTG through a friendly web console. This opens with a network overview showing the status of all sensors, and clicking on any of the icons next to the donut charts takes you directly to a filtered view.



ABOVE You can keep a close eye on sensor usage from PRTG's web console

Alternatively, you can open the device view, which presents a tree structure with all systems organised into hierarchical groups. This may initially look a little overwhelming for large networks, but you can organise things by creating your own groups and moving devices into them, whereupon they inherit settings such as discovery schedules and login credentials. It's easy to spot devices with issues as all sensors icons are colour-coded, and hovering the mouse pointer over any device pops up a window with live graphs and alert messages.

This page is also where you'll discover how quickly the sensor count gets consumed. For example, we found that our 24-port Gigabit switch, Hyper-V and VMware hosts and five-bay Synology NAS appliance had together been allocated a total of 192 sensors. Don't panic, though – with just a few clicks we were able to remove sensors we didn't need and reassign them where we wanted them. You can also add sensors for services that aren't on the local network. PRTG supports a whole heap of cloud providers, including Dropbox, OneDrive, Microsoft 365 services and Amazon CloudWatch. Those using Azure can also set up sensors to monitor SQL databases, cloud VMs, storage and subscription costs, with more advanced sensors currently in development. All of this makes it far more flexible than the typical per-device monitoring suite.

> "PRTG relieved us of a lot of legwork by automatically assigning a suitable set of sensors to each detected device on the network"

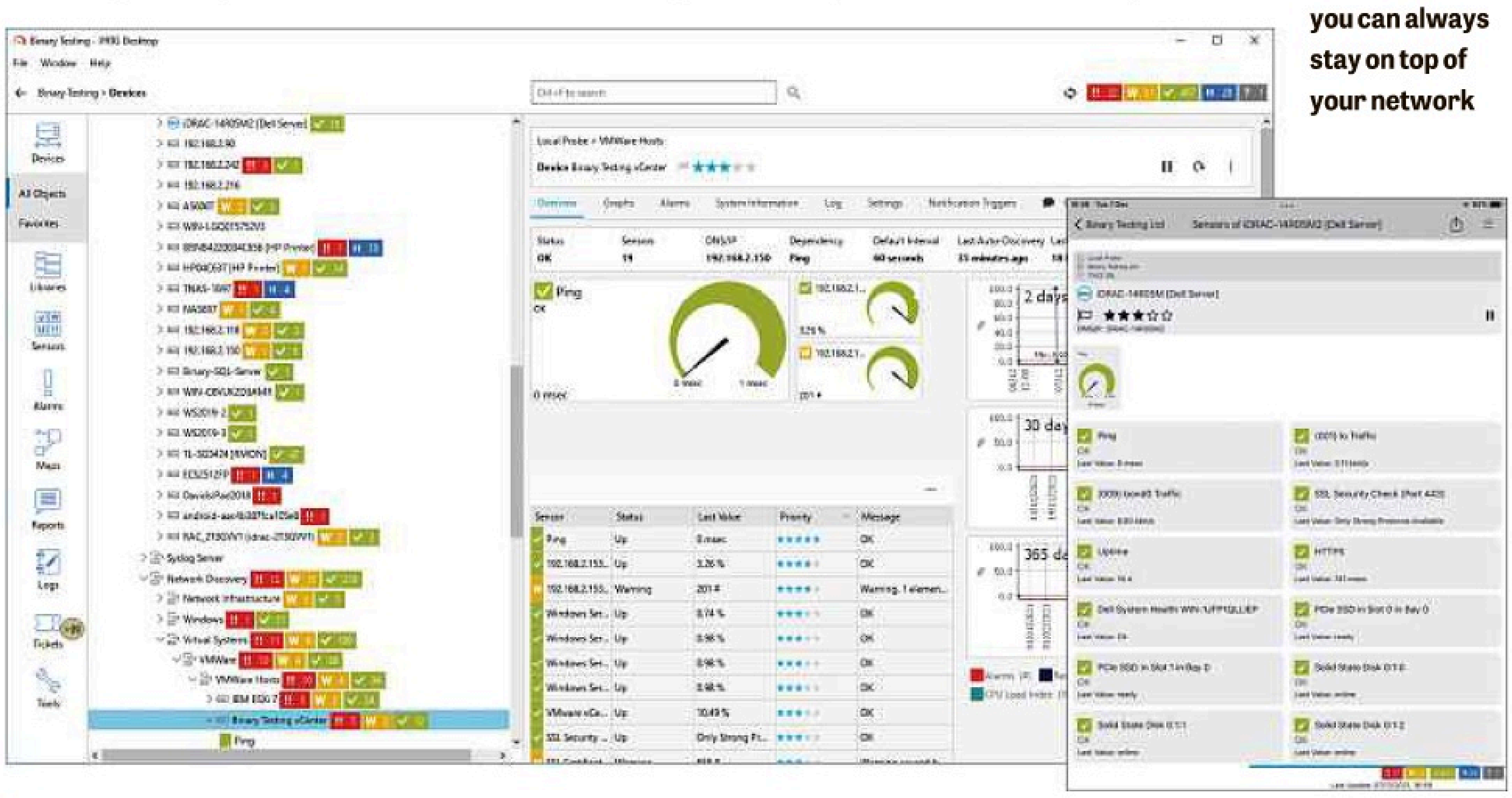
Aside from the web console, you can keep an eye on network activity using Paessler's desktop apps for Windows and macOS, which log in to the PRTG host and present an equally detailed summary of all sensors. Mobile access isn't a problem either, as the free PRTG apps for Android and iOS are easily the best of their kind.

Even when you're not actively checking up on your network, PRTG ensures you're kept in the loop with an extensive range of notification methods, including email, SMS, Syslog, Slack, Microsoft Teams and an MQTT service for IoT devices. Custom triggers can be applied to any level of the device tree or to individual sensors – for example, alerts can be sent when a device goes offline, when a traffic threshold has been breached or when a hard disk is getting full.

In all, when it comes to on-premises monitoring solutions, PRTG Network Monitor is very hard to beat. It provides a terrific range of sensor options for both local devices and cloud services, along with plenty of monitoring facilities, yet it's easy to manage, and comes with a simple, affordable pricing scheme that's perfect for SMBs.

REQUIREMENTS

Windows Server 2012 R2 upwards (.NET 4.7.2 minimum)



BELOW Desktop and mobile apps ensure you can always stay on top of your network

Progress Software WhatsUp Gold 2021.1

Add-ons increase the price, but WhatsUp Gold is easy to use and provides a superb range of monitoring tools

SCORE ★★★★☆

PRICE 25 devices, Premium licence, $2,740 from whatsupgold.com

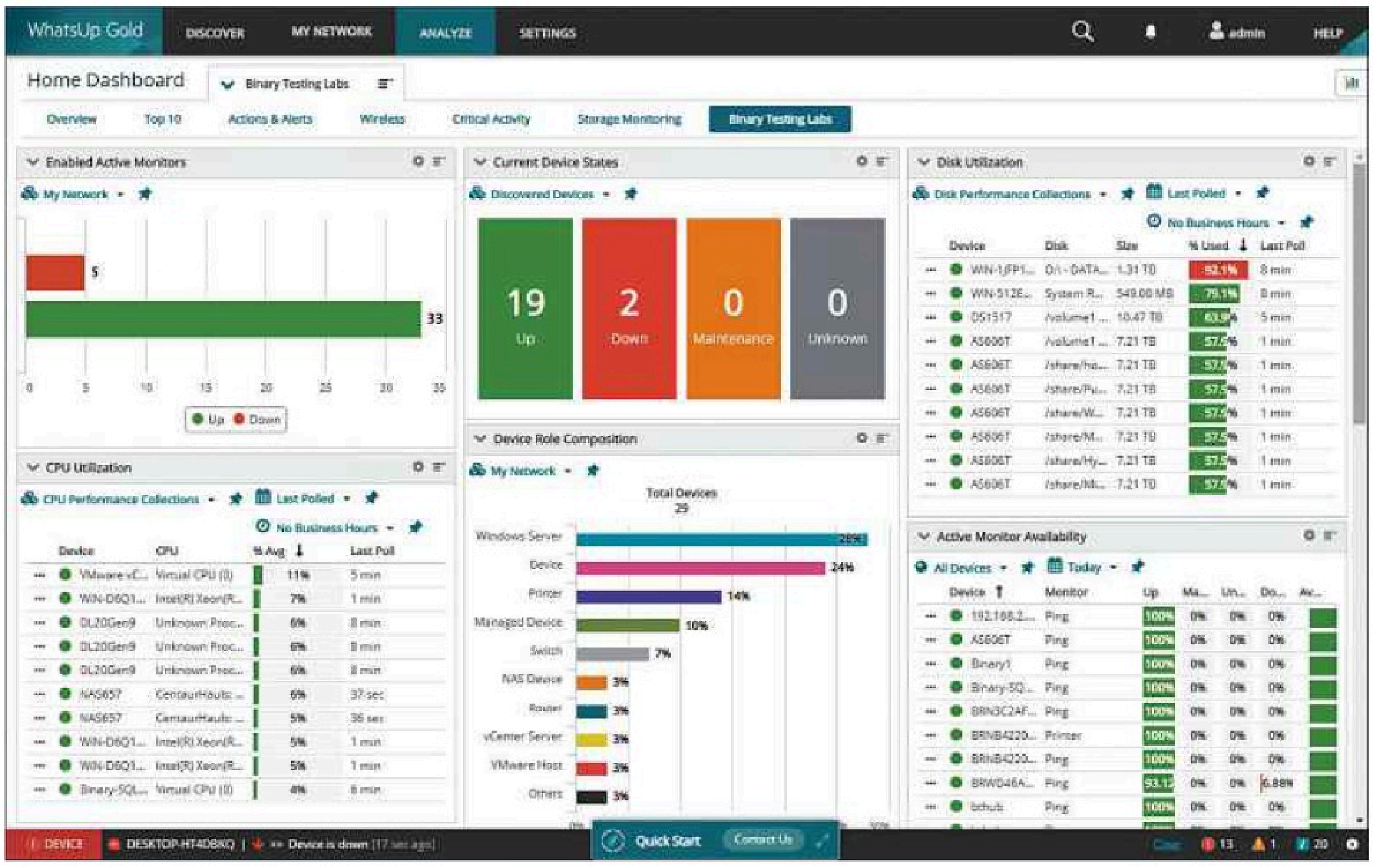
WhatsUp Gold (WUG) has been a popular network-monitoring solution since the 1990s, thanks to its excellent ease of use and extensive troubleshooting features. And publisher Progress Software isn't resting on its laurels: this latest edition gains the ability to collect Windows Event Log and Syslog events, with extensive log search, filtering and export facilities courtesy of the Elasticsearch analytics engine.

Licensing is fairly straightforward. The Premium edition can be had as either a yearly subscriptions or a perpetual licence, and is priced according to the number of monitored devices, regardless of how many ports or CPU cores they have.

All the key features we'd want to see are here, including network discovery, device, cloud, wireless network and storage monitoring, plus alerting and reporting. However, the new log-management features are an optional add-on package, and further add-ons are required for monitoring virtualisation hosts and applications, and performing network traffic analysis. Larger businesses may find the Total Plus edition more practical as it includes all these add-on components as standard. It also uses a more flexible points-based licensing scheme, with devices, servers and VMs counting as one point and log data sources and monitored applications each counting for ten.

Installing WUG 2021 on a Windows Server 2019 host took us around 25 minutes, after which the software got to work and immediately offered to run a network discovery. Once we'd provided our network details, device credentials and a schedule, it churned away for around 15 minutes before reporting back with a complete list of discovered devices.

Keeping track of all these devices is easy. Each item is assigned a colour-coded icon in the web console, so you can see immediately what's up and what's down, and custom policies can be created, linked with state changes and assigned actions such as running a script, restarting a service or sending emails. Dashboards present live graphical overviews of your network and can be customised to your taste, giving you the ability to set up big-screen NOC views for support staff.


WhatsUp Gold
DISCOVER
MY NETWORK
ANALYZE
SETTINGS
Home Dashboard
Binary Testing Labs
Overview
Top 10
Actions & Alerts
Wireless
Critical Activity
Storage Monitoring
Binary Testing Labs
Enabled Active Monitors
Current Device States
Disk Utilization
19 Up
2 Down
0 Maintenance
0 Unknown
CPU Utilization
Device Role Composition
Total Devices 29
Active Monitor Availability
Quick Start

ABOVE Custom dashboards show your choice of devices and status views

PC PRO RECOMMENDED

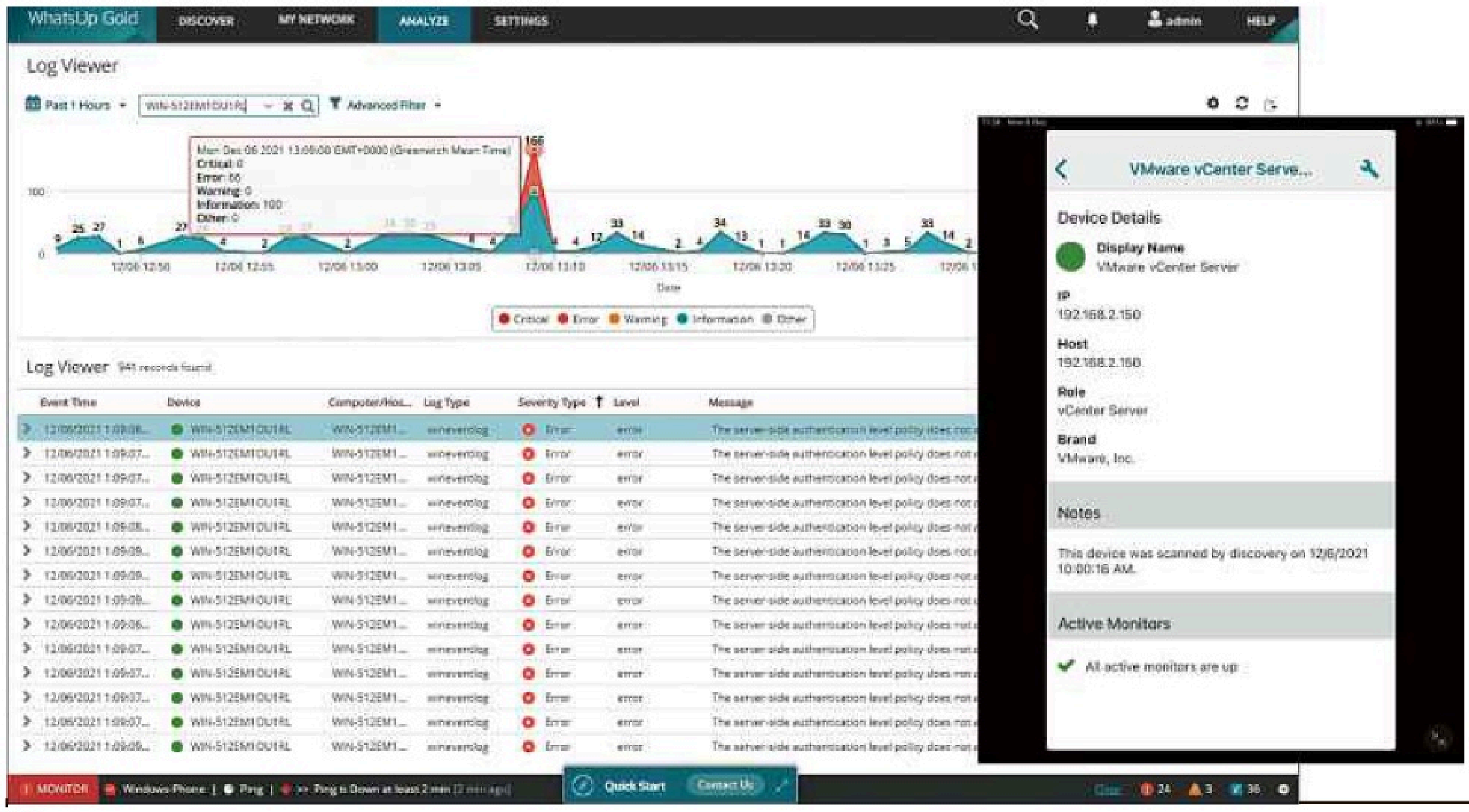
> **"A search facility helps you find logs of interest, and acquiring data is a cinch, as WUG presents all eligible sources for swift selection"**

Tabs and menus provide access to the rest of the major features, enabling you to quickly run network discoveries, view your network topology, switch to an interactive network map view, access a wealth of analysis views and configure settings for WUG and any add-on modules.

Log management is accessed from the Analyze tab. A search facility helps you quickly find logs of interest, and acquiring data is a cinch, as WUG presents all eligible sources for swift selection. On selecting our Windows servers we were prompted to select from application, system and security logs, and to decide whether or not we wanted to see critical, error, warning and informational-level events. You can fine-tune the information view with advanced filters, set thresholds so that unusual activity will trigger an alert and define a datastore and retention time in days, months or years for archived logs. Just note that the standard installation uses the open-source Elasticsearch engine, which only accepts connections from the WUG 2021 host. If you want to increase security with authentication and encryption, you'll have to source the standard version of Elasticsearch and direct the WUG host to it.

WhatsUp Gold 2021 offers an impressive range of network-monitoring tools, with flexible licensing plans to suit companies of all sizes. The smartly designed and informative web console will keep downtime to a minimum, and the new log-management features make it more powerful than ever.

BELOW WUG's log management add-on provides a wealth of valuable information


WhatsUp Gold
DISCOVER
MY NETWORK
ANALYZE
SETTINGS
Log Viewer
Past 1 Hours
Advanced Filter
Critical
Error
Warning
Information
Other
Event Time
Device
Computer/Host
Log Type
Severity Type
Level
Message
VMware vCenter Server
Device Details
Display Name
VMware vCenter Server
IP
192.168.2.150
Host
192.168.2.150
Role
vCenter Server
Brand
VMware, Inc.
Notes
Active Monitors
All active monitors are up
Quick Start

This device was scanned by discovery on 12/6/2021 10:00:16 AM.

REQUIREMENTS

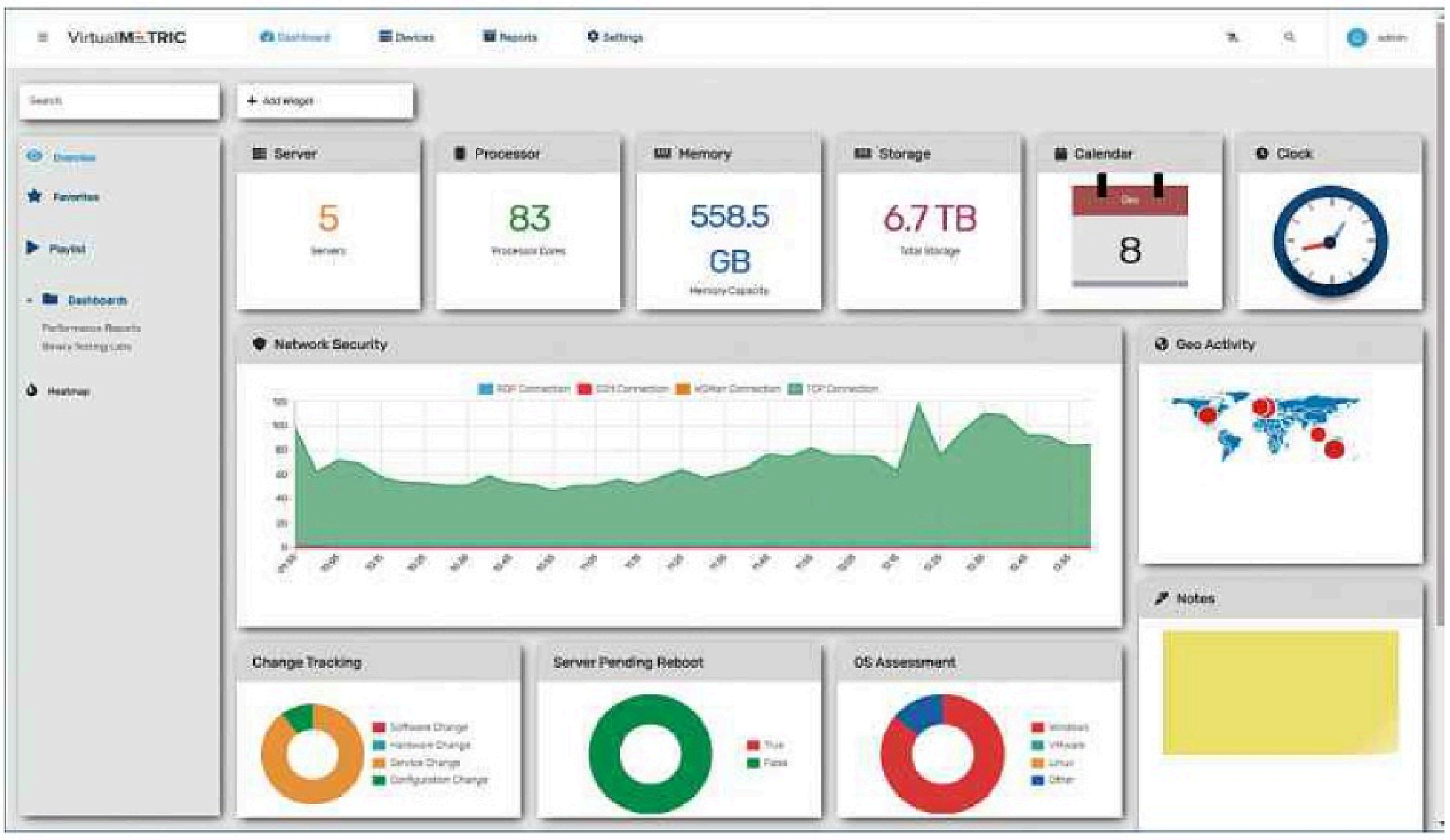
Windows 2012 R2 upwards

VirtualMetric

This server-focused solution exposes a remarkable amount of information, but its flaws are hard to overlook

SCORE ★★☆☆☆

PRICE 1 server/VM, €99 per year exc VAT from virtualmetric.com


VirtualMETRIC
Dashboard
Devices
Reports
Settings
Search
+ Add Widget
Overview
Favorites
Playlist
Dashboards
Performance Reports
Binary Testing Labs
Heatmap
Server
5
Servers
Processor
83
Processor Cores
Memory
558.5 GB
Memory Capacity
Storage
6.7 TB
Total Storage
Calendar
8
Clock
Network Security
RDP Connection
SSH Connection
vSphere Connection
TCP Connection
Geo Activity
Notes
Change Tracking
Software Change
Hardware Change
Service Change
Configuration Change
Server Pending Reboot
True
False
OS Assessment
Windows
VMware
Linux
Other

ABOVE Besides regular monitoring, VirtualMetric offers change tracking and security assessments

VirtualMetric may not be so well known in the network-monitoring world as old-timers such as PRTG and WhatsUp Gold, but it makes its mark with an impressive range of features. It offers real-time agentless monitoring of both physical and virtual servers, works with numerous popular business apps and additionally provides log monitoring, change tracking and inventory functions.

Subscription terms are flexible, with monthly and annual options. Each monitored SNMP endpoint costs €2.90 or €29 respectively, while one physical server or virtual machine will cost €9.90 or €99.

Installing the software takes just two minutes, but be aware that VirtualMetric requires a minimum of Windows Server 2016, plus SQL Server 2014 or higher. We used a Windows Server 2019 host, and for our lab environment we found Microsoft's free SQL Server 2014 Express worked fine.

Once you're set up with the software, there's more work to do. VirtualMetric doesn't offer any auto-discovery services, so you have to open up the web console and manually declare each Windows server in turn, by entering its fully qualified domain name or IP address and supplying administrative credentials (unless you're using Active Directory authentication). VirtualMetric then scans each system for around ten minutes before presenting it in the devices page for further inspection.

The amount of information the program provides is impressive. For each server you get graphs of overall and per-core CPU utilisation, details of total and used RAM and indications of traffic on each network adapter. Storage reports are excellent, too; selecting a volume brings up not just its total and used capacity, but also performance measurements in IOPS and latency graphs. And at the server system level you get a detailed hardware inventory, lists of running processes and services, installed software, firewall rules and more.

The audit and security sections are equally powerful. These track all changes to each system's hardware and software since it was first scanned, along with Windows event logs and detected file changes. Since VirtualMetric uses Windows Defender reports to highlight security threats, it can also tell you about installed hotfixes and pending Windows updates.

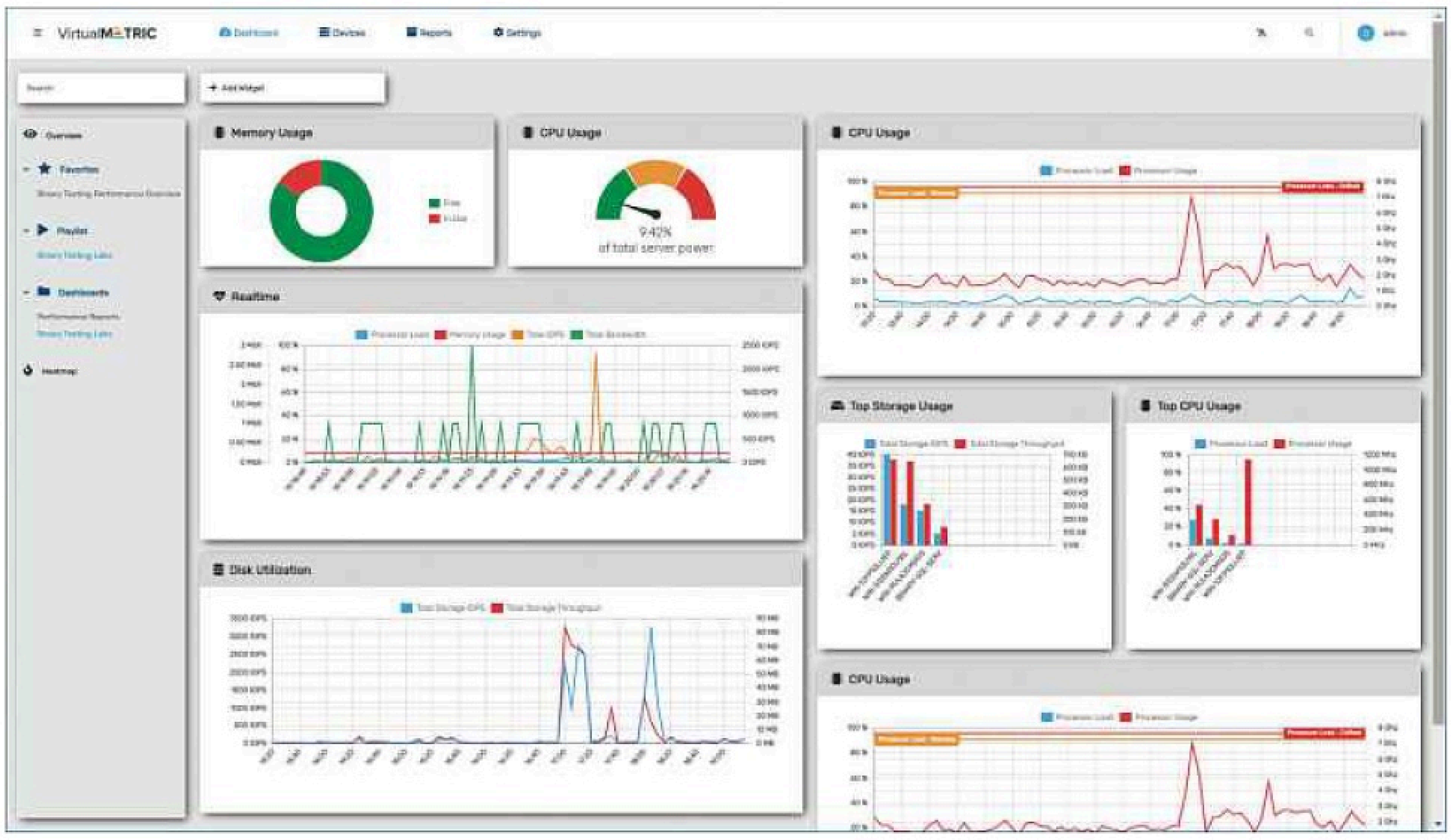
To monitor Hyper-V servers you need to install an extra module from the devices view, but this only takes a minute, with other modules provided for monitoring IIS, Exchange, SQL Server, Storage Spaces and Active Directory.

> **"Installing the software takes just two minutes, but requires a minimum of Windows Server 2016, plus SQL Server 2014 or higher"**

Unfortunately, we couldn't get VirtualMetric to connect to our VMware ESXi 7 and vCenter server, and the outdated online documentation was no help. Contacting support proved equally useless: we submitted multiple questions over a two-week period, but received only a few unhelpful emails back.

Console dashboards can be customised with a range of graphs, including a by-the-second real-time view of all server utilisation, and you can create your own favourites and add extra widgets for any metered data. The playlist option is a nice touch, combining sets of screens with different widgets and presenting support staff with a scrolling heads-up network status display.

VirtualMetric offers a lot of potential for network engineers wanting a detailed, customisable monitoring solution. It's not as easy to set up as other options, though; we'd be very hesitant to recommend this product to SMBs with limited IT expertise, especially in light of our poor support experience.


VirtualMETRIC
Dashboard
Devices
Reports
Settings
Search
+ Add Widget
Overview
Favorites
Playlist
Dashboards
Heatmap
Memory Usage
Free
In Use
CPU Usage
9.42%
of total server power
CPU Usage
Realtime
Disk Utilization
Top Storage Usage
Top CPU Usage
CPU Usage

BELOW Dashboards can be customised with a range of informative widgets

REQUIREMENTS Windows Server 2016, SQL Server 2014/Express upwards

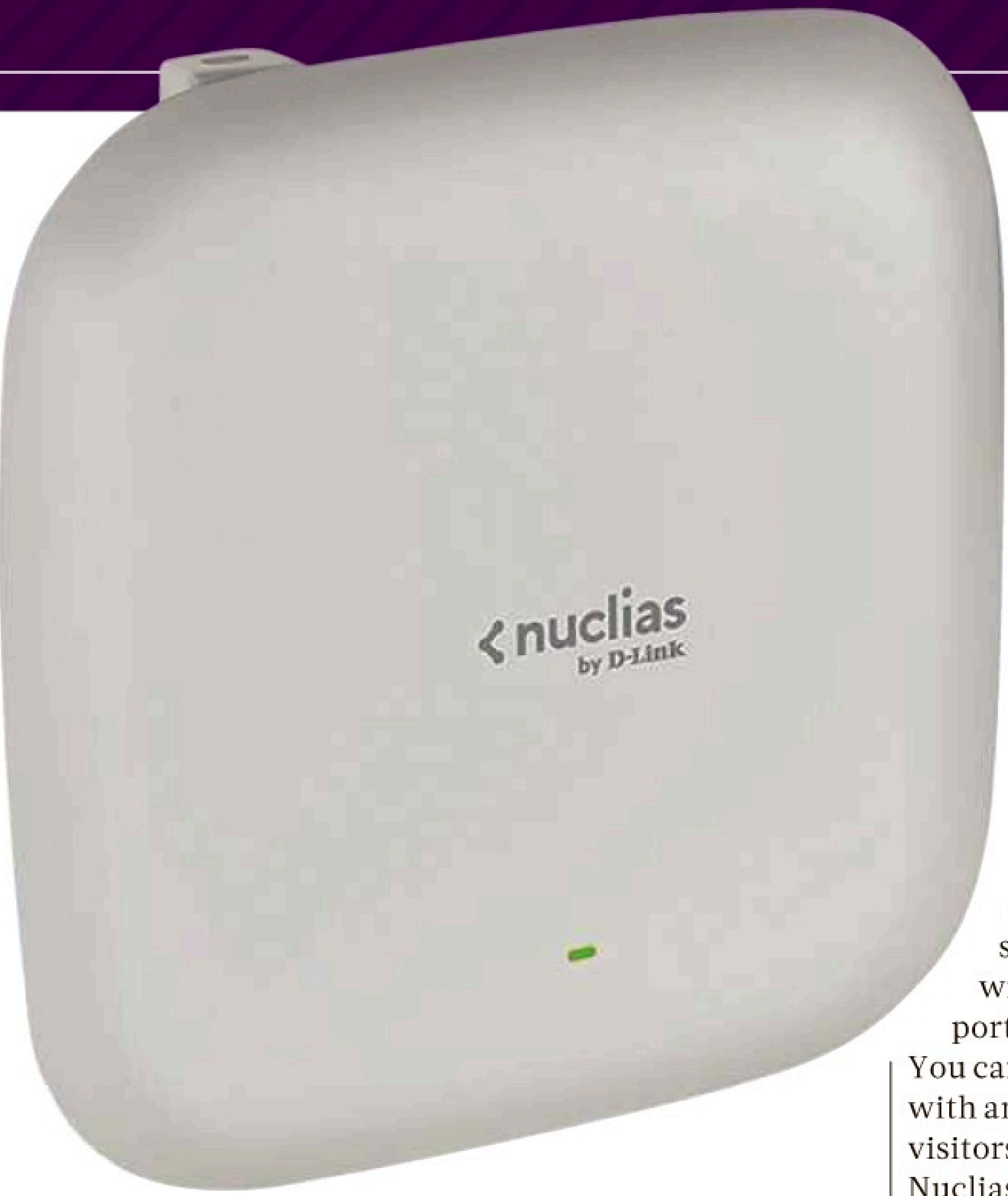
OPTIONS Socket licence €30/month, €299/year

D-Link Nuclias DBA-X1230P

Not the best value, but this cloud-managed Wi-Fi 6 AP is a good performer with top-notch guest services

SCORE ★★★★☆

PRICE £183 exc VAT from broadbandbuyer.com



ABOVE This modest-looking box delivers great speeds for an AX1800-rated AP

With fierce competition in the SMB Wi-Fi market, vendors need to offer something special to stand out. Enter D-Link's Nuclias access points (APs), which offer full cloud management, plenty of business-class features and a choice of models at different speeds.

We tried out the entry-level DBA-X1230P, which claims an AX1800 performance rating. That's arrived at by totting up theoretical speeds of 1,200Mbits/sec on its 5GHz radio and 600Mbits/sec on the 2.4GHz band. It isn't the cheapest AX1800 AP we've seen – Netgear's WAX610 (*see issue 319, p100*) only costs £130 – but it's better value than it appears, as the price includes your first year's subscription to D-Link's Nuclias cloud-management platform.

You'll need it, as the DBA-X1230P doesn't support standalone operations. But keeping your cloud subscription going isn't expensive, with a further one-year licence costing £43 per AP, or £130 for three years.

The Nuclias web portal provides all the management conveniences you'd expect. You start out by creating a parent organisation for your company, and then define sites for each office location. When you add an address for each one it appears in its rightful place in the dashboard's company map, and you can then start setting up profiles to control each site's wireless services.

D-Link helpfully provides profile templates for each Nuclias-managed AP model. These can be tweaked to suit and offer plenty of customisable options: you can decide which radios are active, create up to eight SSIDs for each one, optionally enforce strong WPA3 encryption and enable station isolation to keep wireless users away from the local network.

For testing, we hooked up the DBA-X1230P to the lab's EnGenius ECS2512FP PoE++ multi-Gig switch. This worked perfectly well, but if you use one of D-Link's DBS-2000 series of PoE switches, then this too can be managed from Nuclias, with yearly renewals costing £22 per switch.

It took us mere moments to add the AP to our cloud account; we achieved this by installing the Nuclias iOS app on an iPad, then using it to scan the QR code on its label. The app invited us to assign the AP to our site and let us choose a profile before the unit was plugged in. Once powered on, the AP automatically registered itself with our account and started presenting the SSIDs we'd defined.

If you've previously used the Nuclias web portal, you'll notice that it's recently been redesigned to focus more on site status and device availability. Sadly this means you now get less information about client activity and traffic throughput, but you can still find this in the mobile app: we were able to browse daily graphs of traffic and connected clients, with readouts of how much data was passing through each AP.

One area where the DBA-X1230P excels is guest networking. With support for up to 16 site SSIDs, there's scope to present multiple guest wireless networks, and captive portal features are outstanding. You can present a click-through page with an acceptable use policy, require visitors to authenticate against a Nuclias-managed user list or connect to third-party providers such as Facebook, Google or Twitter. SMS authentication is an option, too, though to use it you'll need to sign up with Twilio and pay 3p per message. Other guest controls include upload and download traffic limits and daily schedules that determine when guest SSIDs will be available.

PC PRO RECOMMENDED

While the DBS-X1230P doesn't claim a huge amount of bandwidth, it achieved very respectable results in our real-world performance tests. Large file copies between a Windows 10 Pro workstation equipped with a TP-Link Archer TX3000E Wi-Fi 6 PCI-E adapter and a server on our 10GbE LAN were completed at an average speed of 93MB/sec at close range, dropping to a still very creditable 81.5MB/sec when the AP was placed 10m away in an adjoining room.

> **"There's scope to present multiple guest wireless networks, and captive portal features are outstanding"**

There's no getting away from the fact that the DBA-X1230P is comparatively pricey for an AX1800 Wi-Fi 6 AP, and you'll need to factor in the ongoing cost of Nuclias access. For the price, though, you get impressive real-world performance, easy deployment, good cloud management services and superb guest support. **DAVE MITCHELL**

LEFT The DBA-X1230P can be powered from any PoE+ switch, or an optional power supply

SPECIFICATIONS

AX1800 dual-band 2.4GHz/5GHz 802.11ax ● 2 x 2 MU-MIMO ● internal aerials ● Gigabit LAN/802.3at PoE+ ● RJ-45 console port ● power socket ● ceiling/wall mounting kit ● 243 x 243 x 64mm (WDH) ● 680g ● 1yr Nuclias subscription included ● limited lifetime warranty on registration

OPTIONS D-Link Nuclias, 1yr AP licence: £43 exc VAT

Poly Studio P21

This video meeting solution isn't cheap, but it's perfect for home workers seeking the professional touch

SCORE ★★★★☆

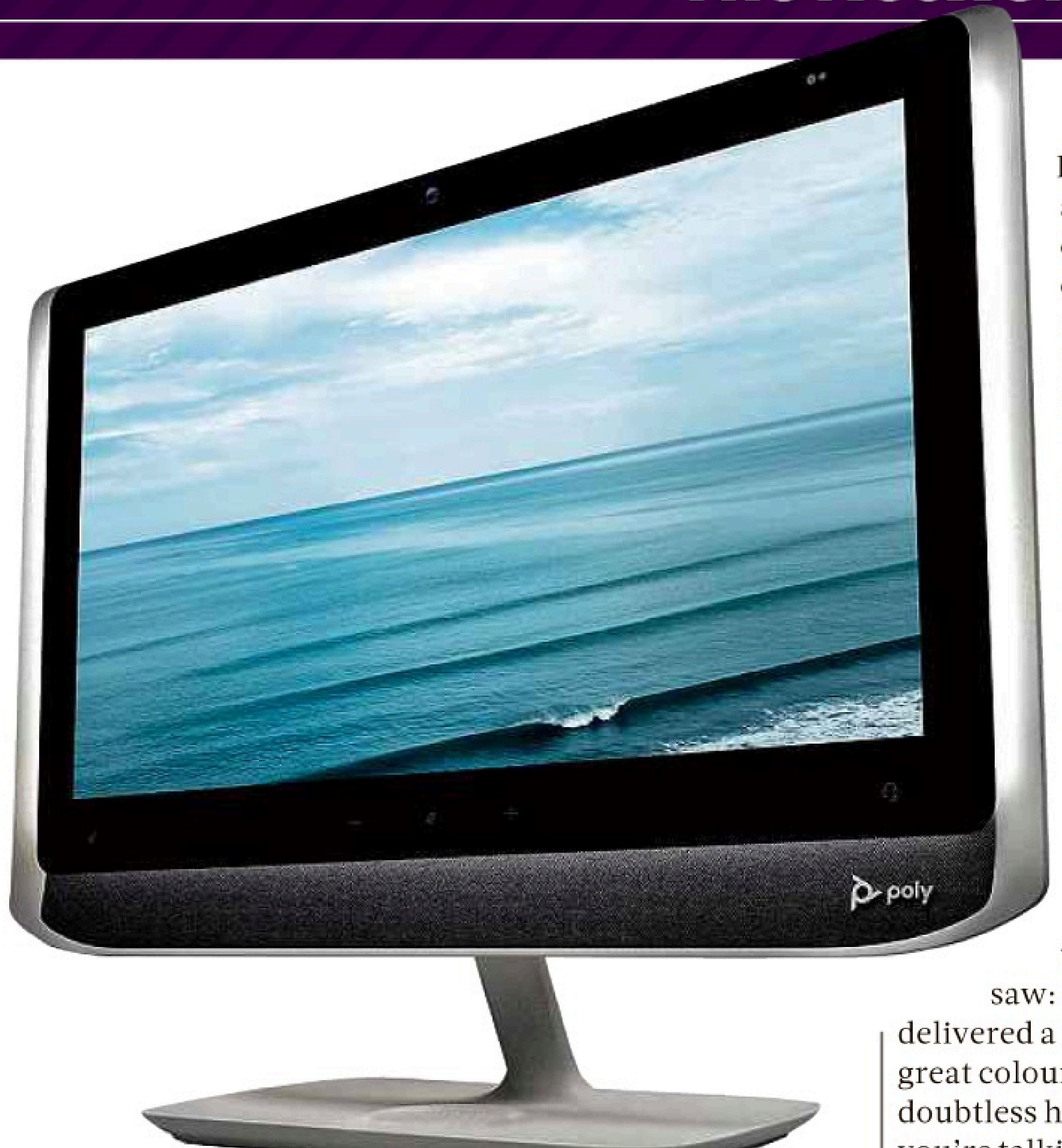
PRICE £620 exc VAT
from best4systems.co.uk

Working from home will be with us for a while yet – indeed, many workers aren't ever planning to return to the office, which means personal videoconferencing is now a regular fact of life. It's time to replace those clip-on cameras and tinny speakers with a proper solution, and Poly has an ideal alternative in the Studio P21, a conveniently sized desktop monitor that integrates everything you need for top-quality video calls.

At first glance the P21 looks like a fairly ordinary 21.5in LCD monitor. It has a standard 1080p resolution and fabric grille across the bottom, which hides a 10W speaker on each side. The first visible clue that it's more than a regular display is the camera set discreetly into the top bezel; look closely and you'll also spot soft buttons below the screen that not only control the volume but can also mute the microphone and trigger a range of custom actions on the host PC, including opening your default videoconferencing app. The LED light strips at each side of the screen have a part to play, too – they help balance out the lighting on your face, so you don't get a blue cast from the screen. Touch sensors at the rear of the screen let you control their brightness by stroking your fingers up and down.

Lastly, while most monitors use HDMI or DisplayPort connections, the P21 connects to the host PC or laptop via USB-C; this allows the video, camera, microphone and speakers to work over a single cable. These peripherals all appear as standard local devices, so they can be used by any UVC-compliant VC app with no special configuration required. Two additional USB-A ports are provided at the back of the screen, which can be used to connect headsets or other devices. They can also deliver 5W of power for charging up phones and tablets, and the monitor stand has a built-in wireless charging plate too, although this only works when the P21 is connected to a host PC.

We had no trouble setting up the monitor on a Windows 10 system. After downloading the DisplayLink driver from Poly's support site, we were able to use Microsoft's DisplayLink Manager app to switch between a local laptop display and the P21, or use the duplicate display feature to mirror our desktop across both panels.



ABOVE The cleanly designed P21 will fit happily onto any desk

"The P21 connects to the host PC or laptop via USB, allowing the video, camera, microphone and speakers to work over a single cable"

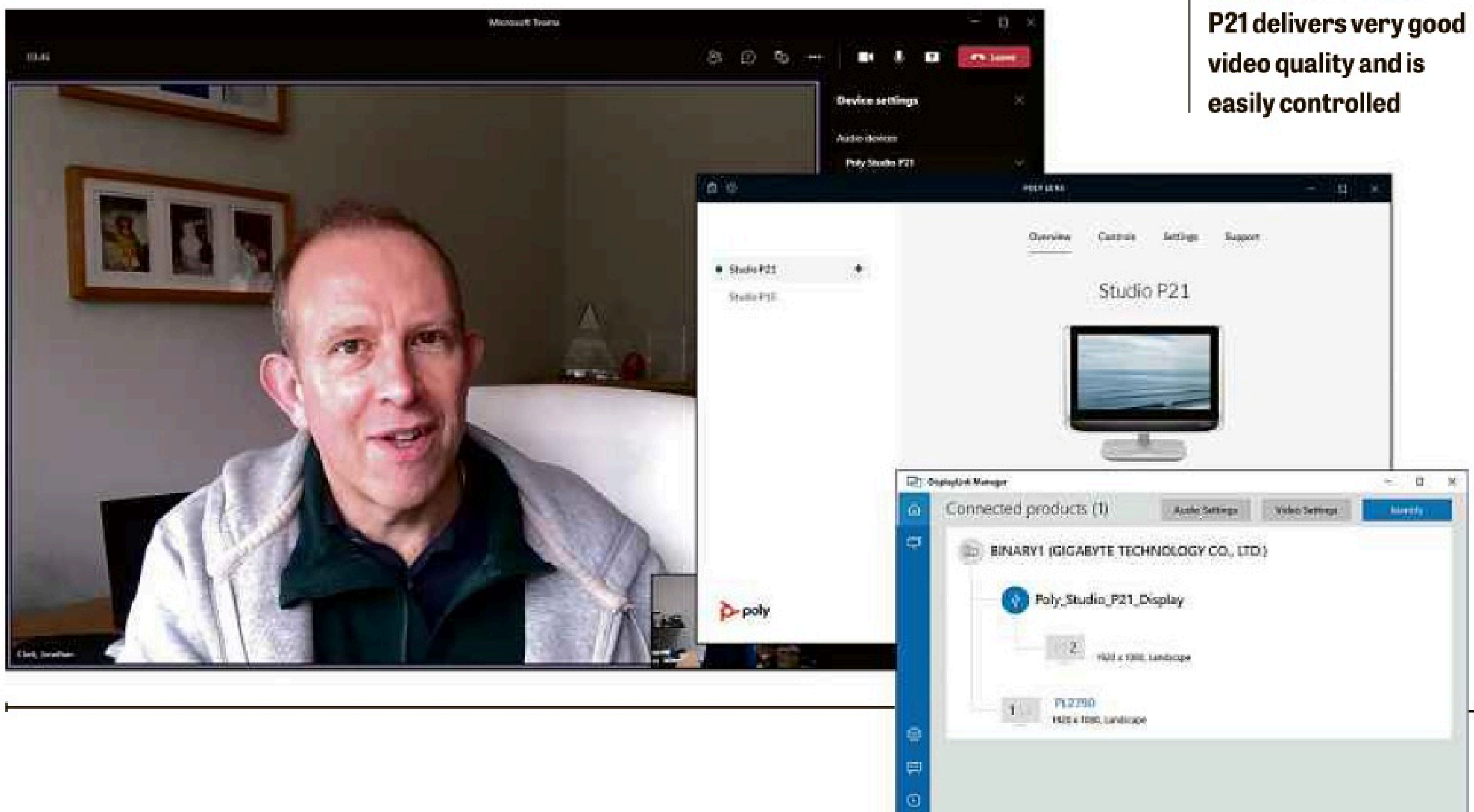
You'll want to install Poly's free Lens Desktop app too, as this provides controls for adjusting the camera's zoom settings, controlling the screen brightness, configuring the programmable "rocket" button and setting the app button to load Microsoft Teams or Zoom. It can also link up with the Poly Lens cloud service for remote management and inventory.

To test out the P21's camera, we set up a remote user with the display, then initiated a Teams meeting with them. We liked what we saw: the 1080p camera delivered a pin-sharp image with great colour balance. The vanity lights doubtless helped here, though if you're talking to someone who wears glasses you may find their reflections a little disconcerting.

We also tried positioning the P21 to face a pair of glass doors to see how it coped with glare. We had to use the Lens app to increase the backlight compensation, but with this done the results were very satisfactory. The twin speakers delivered a clean, solid sound too, and everyone we called from the P21 said they could hear us clearly.

There are a few features you won't find on the P21: Poly's NoiseBlockAI and Acoustic Fence technologies for removing background noises aren't available here, and there's also no speaker tracking or automatic framing. This is a minor disappointment considering the price, but it shouldn't be a problem, as the P21 is designed for personal use rather than meeting rooms.

Poly's Studio P21 is a tempting proposition for home workers that want to look their best in video meetings. Yes, for the same money you could buy a bigger display along with a standalone webcam – but the P21 brings easy setup, handy meeting features and great video quality, without the hassle of separate components. **DAVE MITCHELL**



BELOW The Studio P21 delivers very good video quality and is easily controlled

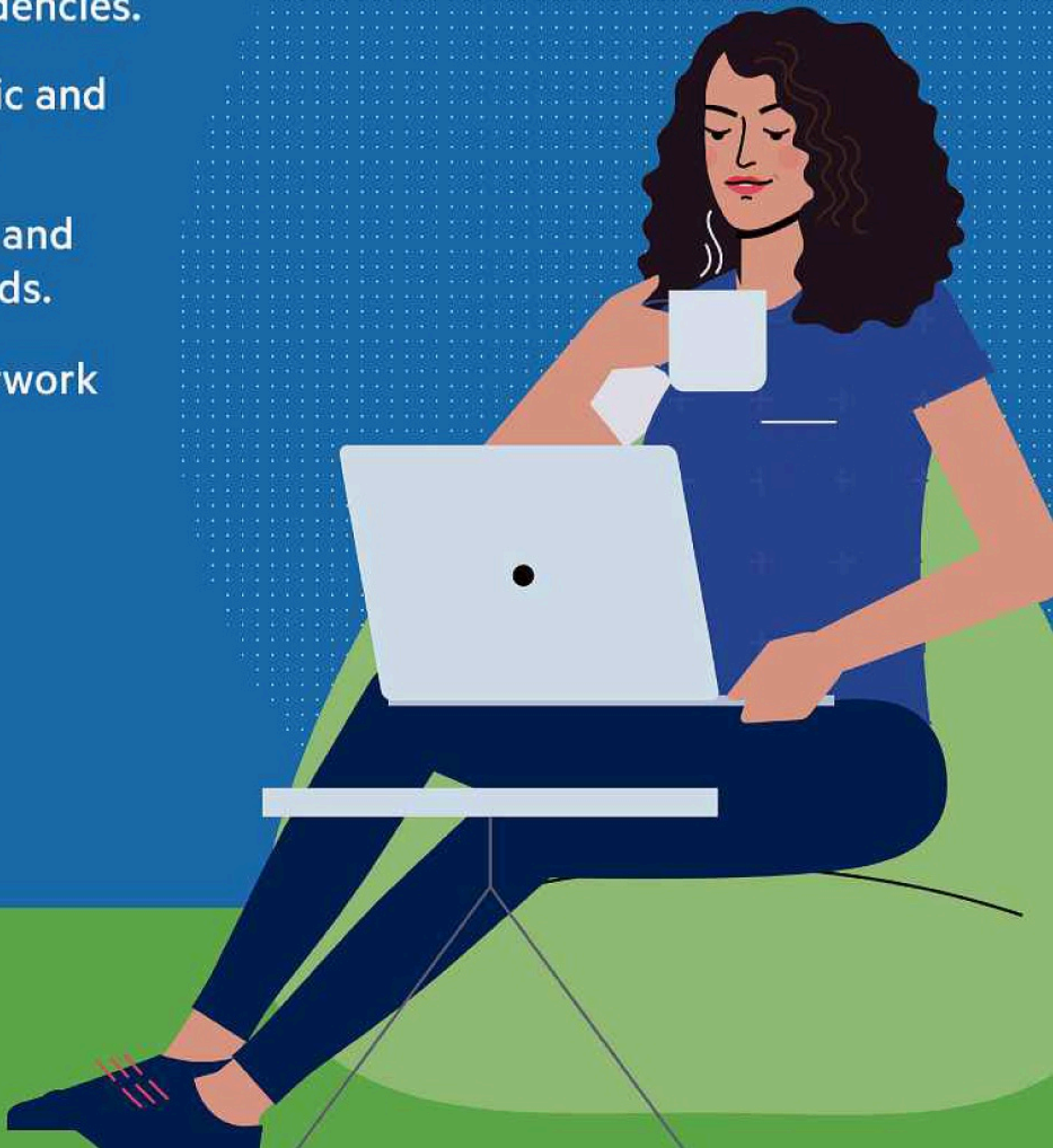
REQUIREMENTS

21.5in 1080p monitor • 1080p camera • 80° field of view • 4x digital zoom • dual 10W stereo speakers • unidirectional MEMS microphone • USB-C 3 • 2 x USB-A 3 • wireless charging pad • 1m USB host cable • external PSU • DisplayLink drivers for Windows and macOS • 575 x 188 x 478mm (WDH) • 6.8kg • 2yr limited warranty

Progress® WhatsUp® Gold

Up/Down Availability and Performance. At-a-Glance.

- Automatically discover, map and visualize device dependencies.
- Optimize network traffic and bandwidth utilization.
- Use actionable, unified and customizable dashboards.
- Quickly find and fix network and server problems.



www.whatsupgold.com

So you've been breached. What now?

Would you know what to do if an online attacker got their hands on your data? **Davey Winder** sets out your first response

As businesses settle into a new post-pandemic normal, cybercriminals have been busier than ever. Check Point Research reports that cyber attacks on corporate networks increased by 50% in 2021 compared to the previous year; by December, businesses were experiencing an average of 925 attacks per week.

Of course, not every attack is successful, and even when criminals do manage to get into your systems, that doesn't always result in a data breach. But you need to plan for that possibility. "We know that data breaches like ransomware are pernicious, effective and on the rise," Ed Williams, director of Trustwave SpiderLabs (EMEA) said. "No matter what the size of the business is, they should be planning for the worst – while ensuring, through good cyber hygiene, that it doesn't happen." We've spoken to incident responders and cybersecurity professionals to determine just what a small-to-medium-sized business should do once a breach has been detected.

Begin at the beginning

Any kind of security response requires a methodical investigation. As Dave MacKinnon, chief security officer with N-able says, this means addressing the five Ws – "who, what, when, where and why?" – and you can also add an H for "how". The first step is identifying what has been targeted, what data or resources have been exposed and how the breach happened. Was an external malicious actor at play, or could a non-malicious insider have been involved? Because mistakes and accidents do happen.

"Based upon your analysis of the Ws, you can then determine what level of response is required," MacKinnon said. At this early point, you should also be asking yourself whether you are actually capable of completing the investigation without external assistance. "It's okay to ask for help," he added. "The largest organisations in the world do it all the time."

The three Cs

While considering the Ws, you should also get moving on the three Cs as quickly as is feasible. These are "confirm, contain and communicate" the breach.

The first step might sound like the easy one, but it's not always as straightforward as it sounds. Kris Mitchell, security operations centre team lead at UK data breach detection and response business Socura, warned that "confirmation and validation is the hardest part of data-breach detection and response. If a business detects a DDoS attack it needs to understand if this is the full extent of the attack, or whether it is a

RANSOMWARE RESPONSE

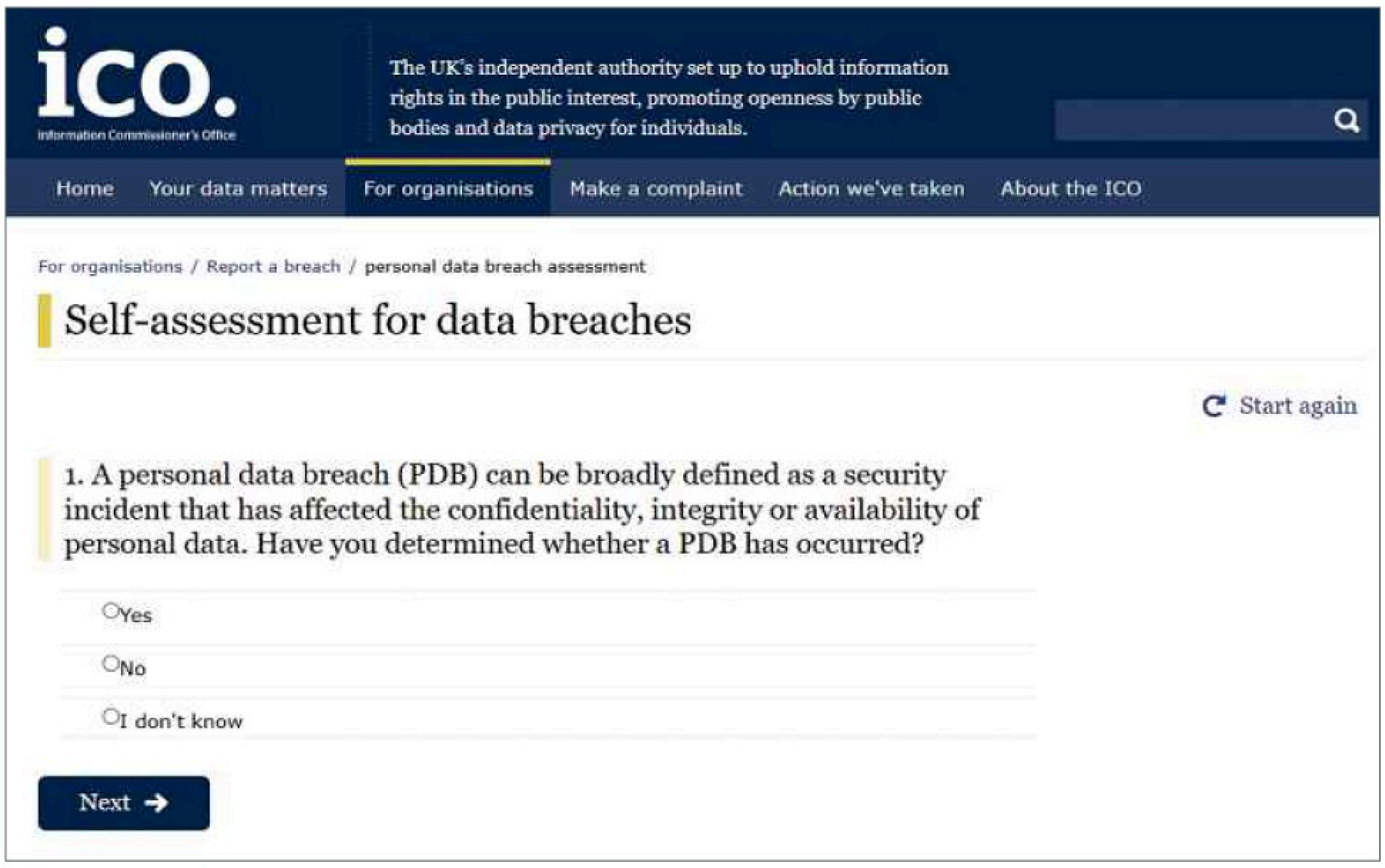
Ransomware incidents can be particularly difficult to deal with because you have to tackle all the challenges of a security or privacy breach in circumstances where your operations are probably paralysed.

"This puts pressure on the organisation to quickly pay the ransom to avoid loss of revenue and the reputational damage of leaked data," Oscar Arean, head of operations at Databarracks, said.

"Small businesses in particular can be quickly overwhelmed," he continued. "Make sure you have resources available to help. Your insurance company may provide security and forensic specialists, but if not, it's a good idea to develop a relationship with specialists that you can call upon if you need them."

smokescreen for something more sinister. It is often a precursor to an attacker exfiltrating data, but only a cybersecurity professional will know to look for data exfiltration during a DDoS and not fall for the distraction."

I'd argue that "keep calm" should be a fourth C on the list. Panicking won't help your breach response, but it's understandable if you've been wrong-footed. "There is nothing worse than suffering a cyber security incident and then trying to work out what needs to be done," commented Cliff Martin, cyber incident responder of GRC International Group. The secret is to have an incident response plan already in place that you can turn to. "Having a plan up front will significantly reduce the impact and time taken to recover," Martin said – and it can also assist greatly with the next C, containment.



The UK's independent authority set up to uphold information rights in the public interest, promoting openness by public bodies and data privacy for individuals.

For organisations / Report a breach / personal data breach assessment

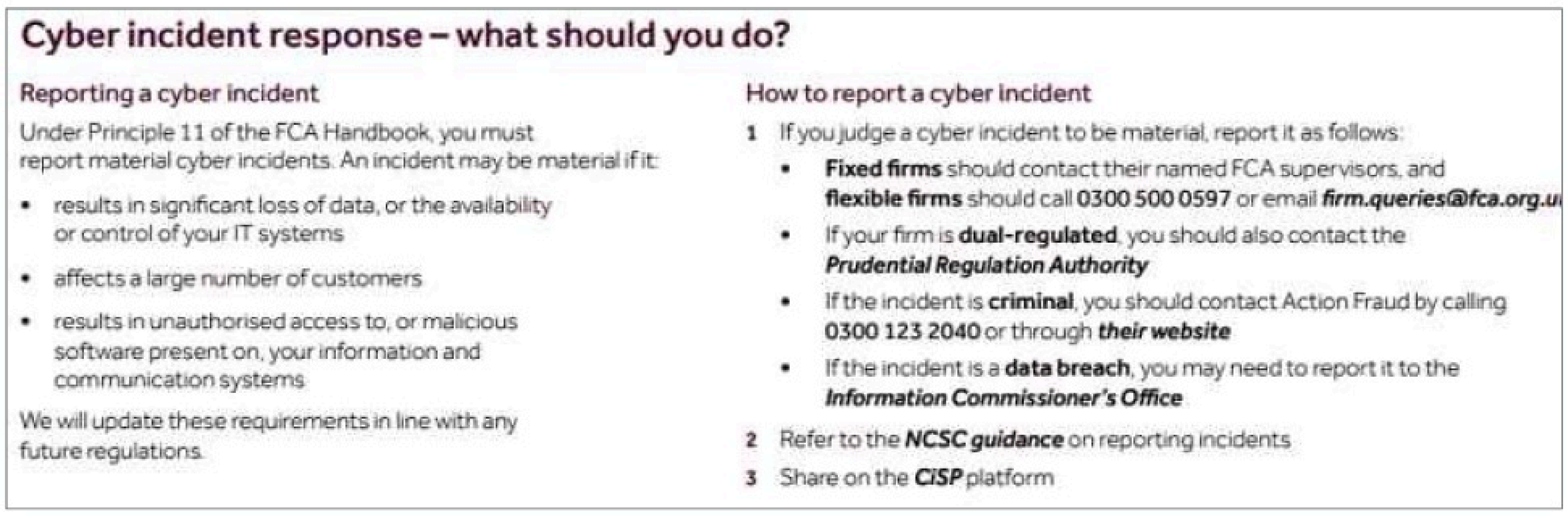
Self-assessment for data breaches

1. A personal data breach (PDB) can be broadly defined as a security incident that has affected the confidentiality, integrity or availability of personal data. Have you determined whether a PDB has occurred?

○ Yes

○ No

○ I don't know



Cyber incident response – what should you do?

Reporting a cyber incident

Under Principle 11 of the FCA Handbook, you must report material cyber incidents. An incident may be material if it:

- results in significant loss of data, or the availability or control of your IT systems
- affects a large number of customers
- results in unauthorised access to, or malicious software present on, your information and communication systems

We will update these requirements in line with any future regulations.

How to report a cyber incident

1 If you judge a cyber incident to be material, report it as follows:
  - **Fixed firms** should contact their named FCA supervisors, and **flexible firms** should call 0300 500 0597 or email ***firm.queries@fca.org.u***
  - If your firm is **dual-regulated**, you should also contact the ***Prudential Regulation Authority***
  - If the incident is **criminal**, you should contact Action Fraud by calling 0300 123 2040 or through ***their website***
  - If the incident is a **data breach**, you may need to report it to the ***Information Commissioner's Office***

2 Refer to the ***NCSC guidance*** on reporting incidents

3 Share on the ***CiSP*** platform

TOP If the breach involves personal data, the ICO may need to be told

ABOVE Financial services companies will need to inform the FCA of any incident

Containing the threat

Naturally, in the event of a breach it's an urgent priority to stop the bleeding and limit the threat actor's ability to do more harm. "If you suspect the attacker is still present on your systems," advised Alistair Thompson, product management lead at Adarma, "take steps to deny them access to things that they can use against you." The specifics will, of course, be different for different attack scenarios and business operations, but you might consider temporary measures such as:

- **Restrict access between company devices and external networks**
- **Suspend access between cloud and externally facing services**
- **Disable vulnerable and compromised domain and email accounts**
- **Isolate infected endpoint devices.**

Martin adds that containment can also include "disabling or changing user credentials, blocking specific IP addresses, taking backups or digital images for further analysis and running anti-malware scans".

All of this might sound like a big project, and again this type of scenario is something you should plan for in advance, so you can take action quickly when needed. The smallest of businesses may well have to implement their containment plan themselves, but if you can it's often worth engaging an external expert to help with your incident-response planning: "trust the professionals, not Google," advised Mitchell.

Communication is key

It's embarrassing to admit you've been hacked, but covering up is not an option. If the security incident has led to the destruction, loss, unauthorised disclosure of or access to personal data, then you may be legally required to report it to the ICO within 72 hours. You'll find more information, along with a self-assessment process to determine the status of your incident, at **pcpro.link/330ico**.

When reporting a breach, you'll be required to confirm both the type of data that may be at risk and how many individuals are likely affected; this is one reason why the first C is for confirmation, as getting your facts right is imperative. External support agencies may be able to help with this, but be clear that the ultimate responsibility is yours. "If you enlist the help of a cyber incident response specialist, make sure that they have the relevant legal expertise in data protection and that they are well versed in liaising with the ICO on behalf of their clients," said Pete Bowers, COO at NormCyber. "In some cases, this can be the difference between whether the ICO chooses to impose a fine or not."

Don't think you can just fill in the ICO form and move on, either. "Businesses also have a duty to report all cybercriminal attacks to the police," Mitchell said, "and they should also report phishing attempts to Action Fraud." This isn't likely to result in squad cars showing up at your premises, but, as Mitchell pointed out, "reporting breaches can aid police efforts to catch and prosecute cybercriminal gangs, preventing other businesses from falling victim to the same attacks".

You should also report the incident to the National Cyber Security Centre, and any other bodies that deal with regulatory compliance in your industry – financial services companies will need to report a data breach to the Financial Conduct Authority, for example.

> **"It's often worth engaging an external expert to help with incident-response planning: trust the professionals, not Google"**

Once you've finished talking to the authorities, your next call should be to your insurance company. This isn't just a courtesy call. As Oscar Arean, head of operations at Databarracks, told us: "Insurers can help by providing cyber forensic experts to help deal with the incident. It's also important because if you don't involve them early on, you might not be able to claim back costs you incur."

Then comes the part that businesses, especially smaller ones in competitive sectors, may be particularly hesitant about: contacting customers. But handled properly, disclosure doesn't need to hurt. "Businesses worry that they will lose customers if they think they have a breach," Irfahn Khimji, chief systems engineer at Tripwire noted. "However, the reality is that a well-handled breach response increases customer confidence."

Even if you don't know all the details at first, keeping customers informed that a breach has occurred, and is being investigated, is crucial. "It's better to be transparent about what has happened, and what might be the impact on your customers, than to try and hide facts, lose trust and potentially receive a GDPR fine," said Hugo van den Toorn, manager of offensive security at Outpost24.

The one thing to avoid is apportioning blame. When a breach happens you may naturally want to protest your innocence, but that's the wrong call. "It makes you look bad if you try to pin the blame on someone else," van den Toorn warned. "Take responsibility, and focus on the future; how will things be better now that you've learned this painful lesson?"

The privacy breach response perspective

We've focused so far on data breaches caused by cyber attack, but there are plenty of privacy breaches that are not security incidents. "You might have misconfigured cloud storage making sensitive information publicly available, or an employee might have accidentally emailed sensitive information to the wrong person," said Oscar Arean of Databarracks. Situations such as this are simpler to deal with, though no less serious.

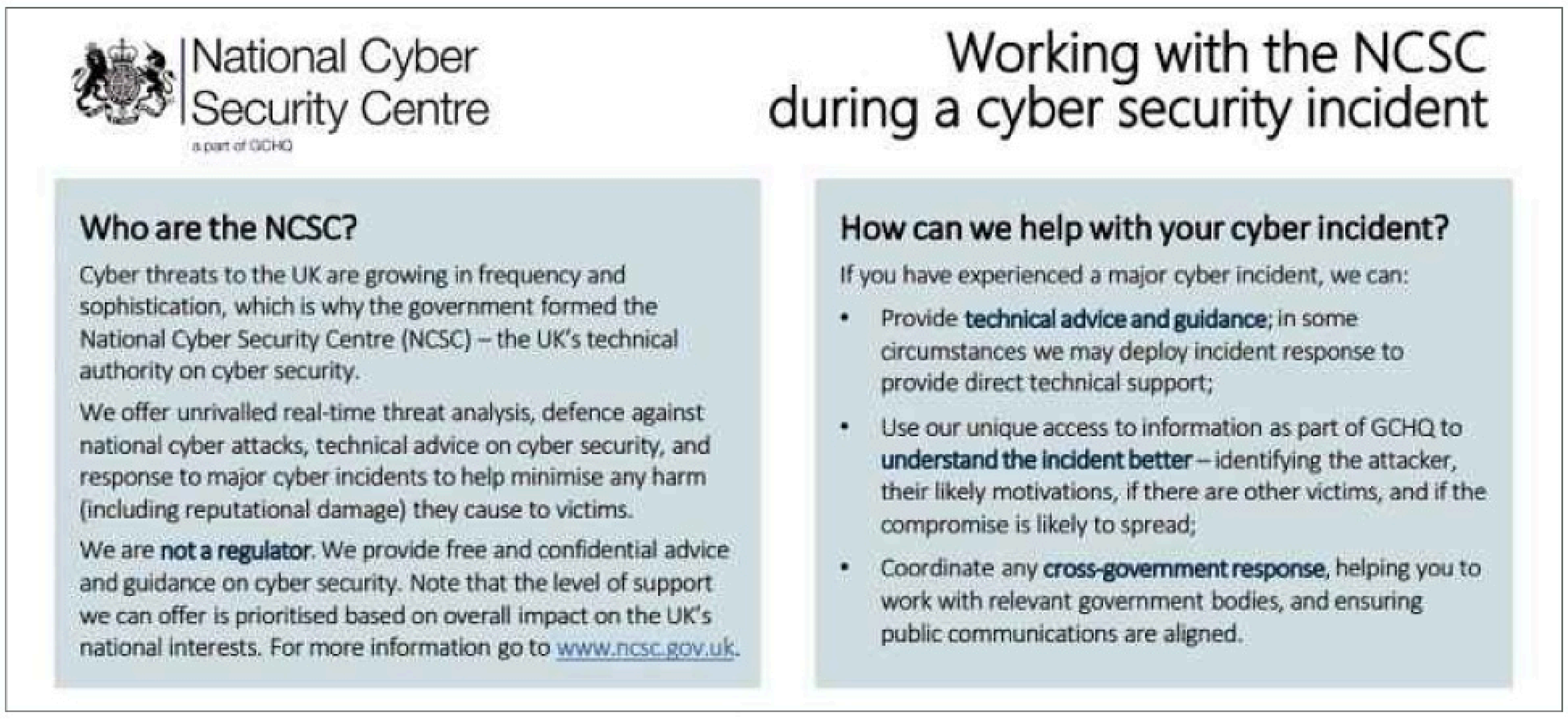
Chris Linnell, senior lead data privacy consultant at Bridewell Consulting, says that the steps to take depend on whether you're dealing with a breach of confidentiality, integrity or availability.

"Confidentiality breaches are unauthorised or inappropriate disclosures or theft of information. They can be via many means, including use of malware, phishing attacks, social engineering or human error," he explained. "In the event of a confidentiality breach, organisations need to quickly ascertain what's been lost or stolen and when, and what technical controls are in place, such as access controls, encryption at rest or in transit, or complex password policies, to mitigate the risk.

"Integrity breaches concern the completeness and reliability of data or assets. These breaches commonly involve viruses or human error in configurations of assets," he continued. "Dependent on the manner of the breach, the focus is likely to be more on data recovery, which is where the use of backups and replication comes in."

That leaves availability breaches, where there is a loss of access or destruction of data. Typically, Linnell explained, this type of breach could be caused by denial of service or ransomware. "In responding to a breach like this, the first step is to work out how the bad actor got in, what has been destroyed, accessed or transferred – and then how to recover from the vulnerability using patching or additional threat detection."

Regardless of the type of breach, you once again need to think about your legal disclosure obligations, and to inform customers and stakeholders. "An organisation will need to ascertain to whom the data belongs," Linnell added, "and where in the world it is being processed, to determine the jurisdiction." For most UK companies the breach will impact the personal data of individuals that reside within the EU or UK, which means it falls under GDPR.



National Cyber Security Centre
a part of GCHQ

Working with the NCSC during a cyber security incident

Who are the NCSC?

Cyber threats to the UK are growing in frequency and sophistication, which is why the government formed the National Cyber Security Centre (NCSC) – the UK's technical authority on cyber security.

We offer unrivalled real-time threat analysis, defence against national cyber attacks, technical advice on cyber security, and response to major cyber incidents to help minimise any harm (including reputational damage) they cause to victims.

We are **not a regulator**. We provide free and confidential advice and guidance on cyber security. Note that the level of support we can offer is prioritised based on overall impact on the UK's national interests. For more information go to www.ncsc.gov.uk.

How can we help with your cyber incident?

If you have experienced a major cyber incident, we can:

- Provide **technical advice and guidance**; in some circumstances we may deploy incident response to provide direct technical support;
- Use our unique access to information as part of GCHQ to **understand the incident better** – identifying the attacker, their likely motivations, if there are other victims, and if the compromise is likely to spread;
- Coordinate any **cross-government response**, helping you to work with relevant government bodies, and ensuring public communications are aligned.

ABOVE The National Cyber Security Centre may be able to help deal with any incidents

> **"There is never a better time to push through improvements than after an incident... did your plan work for you?"**

Long-term action

Once you've addressed the immediate aftermath of a breach, you can start to look at the bigger picture and work to stop the same thing happening again. If you can afford a full security audit – and there's a good argument to suggest that you can't afford not to – then you should be able to uncover the root causes of the breach, as well as other potential security problems that could bite you down the road.

"There is never a better time to push through improvements than after an incident," Arean said. "It's also a good time to review your incident response plan and update it, too. Did the plan work for you, and could it be improved?"

Chester Wisniewski, principal research scientist at Sophos, suggests hiring a penetration testing firm to provide a detailed analysis of your weaknesses and advise on which things you should prioritise for improvement. "Criminals are basically pen testers gone bad," he said, "so having some of the good ones help you identify weaknesses goes a long way."

As Joani Green, managing consultant for incident response at F-Secure, told us: "Traditional prevention tactics are no longer enough for SMEs as threat actors become more advanced. SMEs must possess the ability to predict, prevent, detect and respond against potential threats. For small businesses, this comes down to acquiring basic expertise in all these areas and the solutions to support IT staff." ●

KEEP YOUR BUSINESS RUNNING SAFELY

There's a lot to think about after a breach, but never lose focus on getting your business back online. "A major breach can quickly become an existential threat to your business," said Paul Baird, chief technical security officer UK, Qualys. "If you can get basic services back online, while safeguarding your customers and staff, then do so."

This could take the shape of quickly standing up a temporary cloud-based service and establishing emergency communications to set customer service expectations. "Ask yourself, what is the minimum infrastructure you need to get up and running?" he advised. "It could be as simple as SaaS-based telephony, email, payments processing and ticketing."

In some cases it may be difficult to restore or recover legacy systems; in this event, don't rule out the option of starting from scratch with a new service, if it's the best way to smooth things over for your clients. "Remember one thing," Baird concluded. "You are not the first and will not be the last business to be hit with a cyberattack. It is how you respond to the incident that your customers will remember you for."

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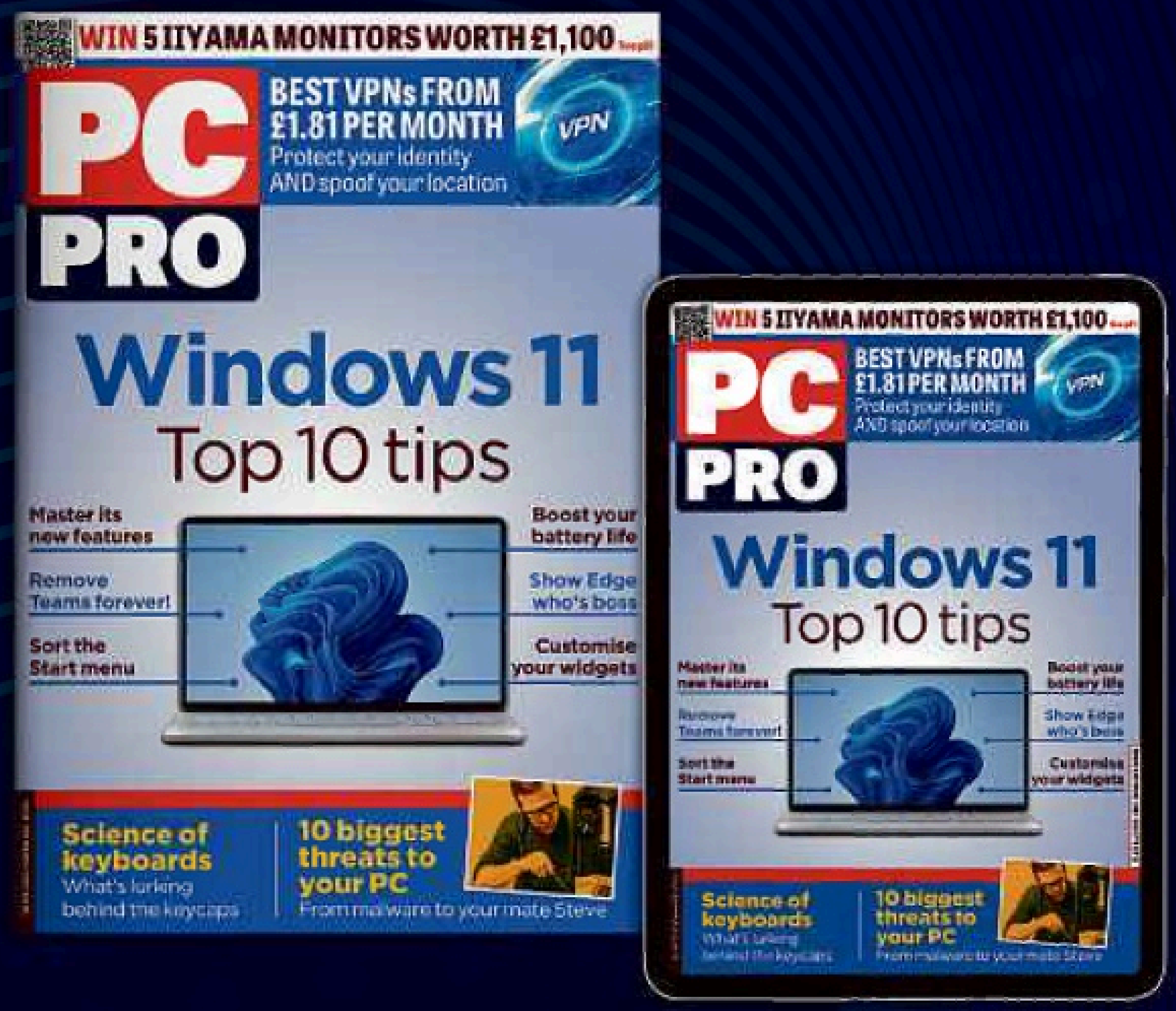
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Real world computing

Expert advice from our panel of professionals

JON HONEYBALL

"I accept that most people just disregard DHCP. But it's too important to simply ignore"

Don't ignore DHCP! That's Jon's plea this month, as he explains why it matters and how some preparation now can make network troubleshooting far easier in the future

We all run DHCP, even if we're unaware of it.

For those in need of a brief refresher, DHCP stands for dynamic host control protocol, and is a service provided by a device on your network; typically a router if you're on a small network and an infrastructure server if you're on a bigger network.

To better understand how DHCP works, let's walk through what happens when you start up your computer or laptop and try to connect to the network. I'll assume that you don't have a fixed IP address already set up in your network configuration, because you like to move your laptop around from network to network, and the IP addressing will change from site to site.

DHCP is basically a client/server system. The client (your computer) makes requests of the server (the DHCP service) and they engage in a conversation. Of course, at this point there is no TCP/IP address assigned to your computer, so everything is done using broadcast packets. The client (your computer) says, in effect, "hi, is there a DHCP server out there?" The DHCP server sees this request and responds back saying it exists. A conversation then ensues where the client asks for a configuration; this will include the IP address, the subnet mask and the default gateway, plus other items that might have been configured to be handed out.

Once the client receives this information, it uses it to configure its network interface, and the computer magically appears on the network.

Naturally, this is a simplistic overview that glosses over many details. For example, the conversation also defines the "lease time", which is the period for which the information handed over is deemed to be valid. The DHCP server also maintains a list of IP addresses it can hand out to DHCP clients, and you can query this list to find out which address was given to which device, checking using the unique MAC address of the network interface of the client.

So DHCP plays a vital role on our networks, and it's important to keep a wary eye on what's going on with it. I accept that most people just disregard it, and usually find it buried away in the depths of the nasty web configuration interface of their router. But it's too important to simply ignore.

Given that the client asks of the network "is there a DHCP server here?" it should be quite obvious that there can only be one that responds "yes". For most simple networks, there can only be one, because only the router manages the list of who gets what. This can cause big problems if a device on your network suddenly decides that it wants to be a DHCP server too.

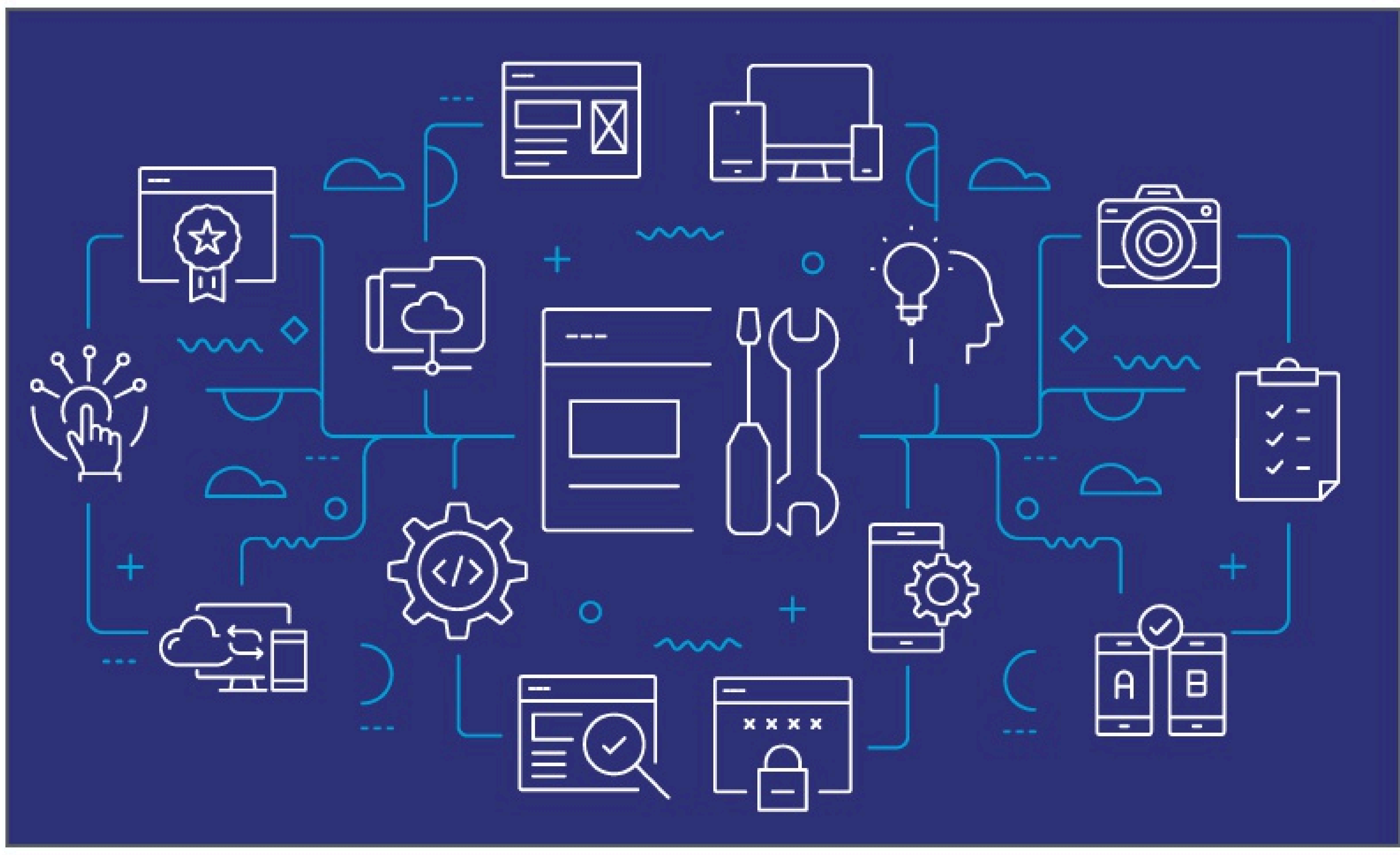
A while ago I detailed how a DHCP server mysteriously appeared on my core network, and it was a pig to locate. Turns out it was a security web camera that had decided to reset itself. On doing so, it ignored the wired Ethernet feed that connected it to my network, then decided to fire up its own Wi-Fi interface. I have mentioned many times how any infrastructure should be on wired Ethernet and not on Wi-Fi, and this especially applies to quasi-real-time devices such as networked security cameras. Anyway, back to my own painful example.

Jon is the MD of an IT consultancy that specialises in testing and deploying kit

@jonhoneyball

To do its initial wireless setup, the camera starts up the Wi-Fi component as a hotspot, broadcasting its own private SSID. It then fires up its own DHCP server, allowing clients to connect directly to the camera's own Wi-Fi hotspot. The camera's DHCP server then hands out an IP address to any connected laptop or phone, and it's easy for the two to talk. The setup process continues, with the idea being that you then tell the Wi-Fi camera the SSID and password of your network. The camera restarts the network stack, turns off the DHCP server in the process, and connects to your wireless network in the same way as any other client.

Still seems simple? It is – right up until the point where my camera decided to enable its Wi-Fi, and most importantly its DHCP server, while still being connected to the Ethernet



BELOW **DHCP hands out addresses to client devices, but things can go wrong...**

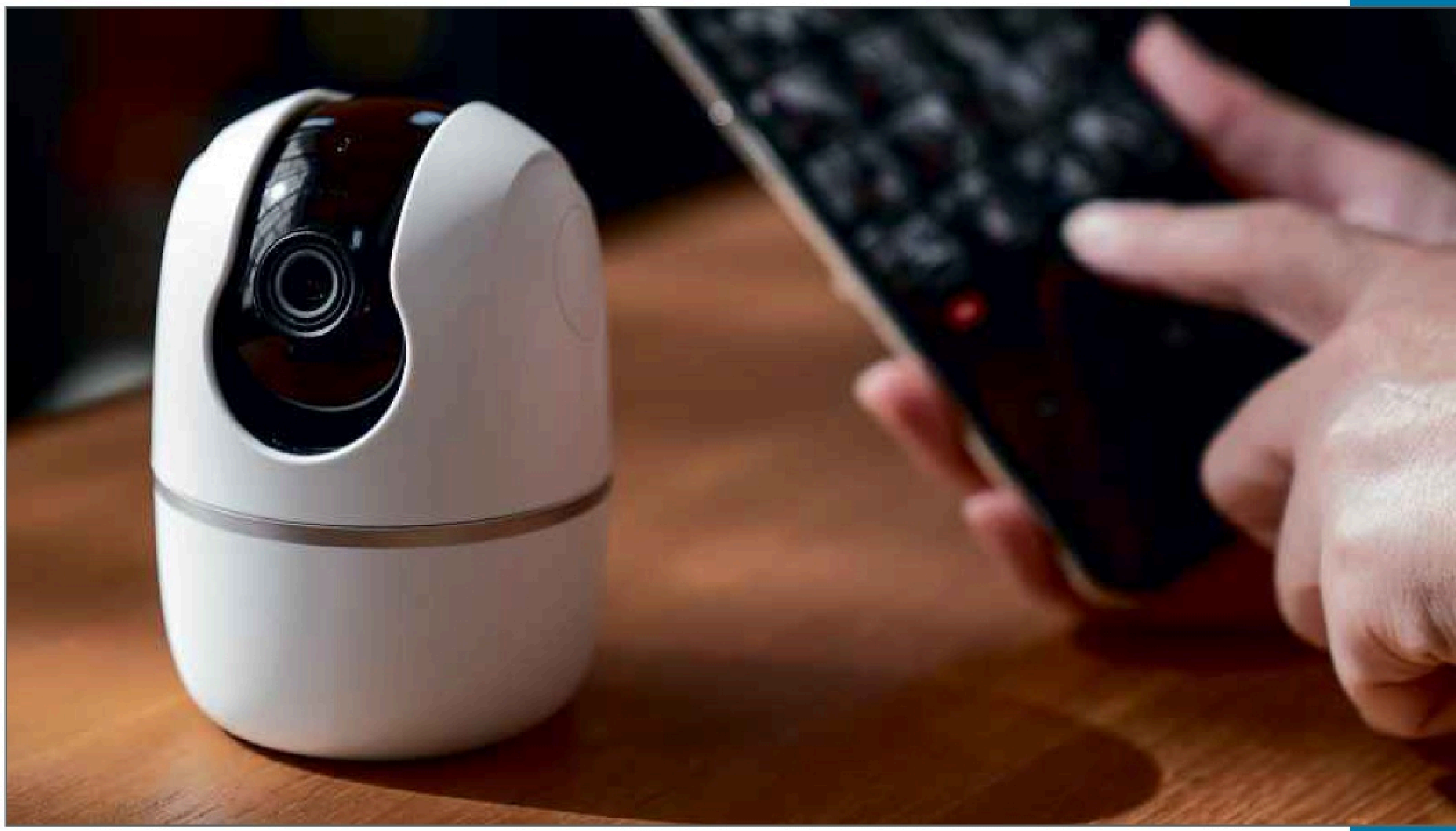
and hence to my core network. Did anyone mention just how buggy most IoT and device firmware is? This rogue DHCP then caused havoc with my network, because any legitimate device joining it might well have heard the rogue Wi-Fi security camera's DHCP server before the core network's DHCP server.

The clue was in the IP addresses that were being handed out. I run 10.101.x.x on my core network, but most devices in IoT land (devices and routers) like to default to the 192.168.x.x address range. When my laptop was given a 192.168.x.x address rather than my legitimate 10.101.x.x range, it was clear that there had to be a rogue DHCP server on the network.

Which is a roundabout way of explaining why good DHCP configuration really matters, why it can quickly ruin your day if things go wrong, and why you can't just ignore it.

Two final tricks I have learned over the years. That defined range of IP addresses in the DHCP server: what happens when it runs out of addresses to hand out? Well, usually things just grind to a halt. If a DHCP server doesn't respond, then the client device is left in limbo. However, Microsoft came up with the wacky idea of enabling a DHCP'ed network where no DHCP server exists. This is called automatic private internet protocol addressing, and essentially each device just grabs an address in the 169.254.x.x range and then tries to talk to other devices in the same boat. If you end up with a 169.254.x.x IP address, it's because your device tried to find a DHCP server and failed.

You'll still see this happen on some big networks, such as those found in hotels. The DHCP server runs out of IP addresses, the lease time was set to be too long so the dead entries aren't recycled fast enough, and you're left in limbo. When this happens, a probe around using fixed IP addresses, along with some good old-fashioned guesswork, will hopefully find out where the default gateway is. And then you just set up an appropriate IP address to talk to the default gateway/router. This probably won't work if the network is doing some fancy VLAN management to push you towards a login gateway, but it's worth a try.



ABOVE Wi-Fi setup of IoT devices works well most of the time, but my camera went rogue

The other trick worth pulling is to set up some reserved IP addresses for your devices. This still uses the DHCP server, but allows it to hand out IP addresses that are outside of its normal range. The idea is that you want your client device to get a fixed, defined IP address range. But you don't want to set this up on each device itself, which is a messy management overhead. Far better to define all of this on the DHCP server itself.

How this works is quite straightforward. As part of that "hello" sequence between the DHCP client and the DHCP server, the MAC address of the client is handed over to the server. Usually this is ignored, and a spare IP address is located on the DHCP table and handed over to the client.

However, a reservation list is almost like a VIP list at a nightclub. The DHCP server looks at the MAC address and decides if it's on the "fixed IP VIP DHCP list". If so, it hands out the IP address you've defined for that client. All the other DHCP settings (subnet mask, default gateway, plus any other DHCP tokens) are handed out from the normal DHCP list in the usual way. By doing this, your client device gets a fixed IP address even though it never asked the DHCP server for it. The client didn't have to be configured with a fixed IP address on the client itself.

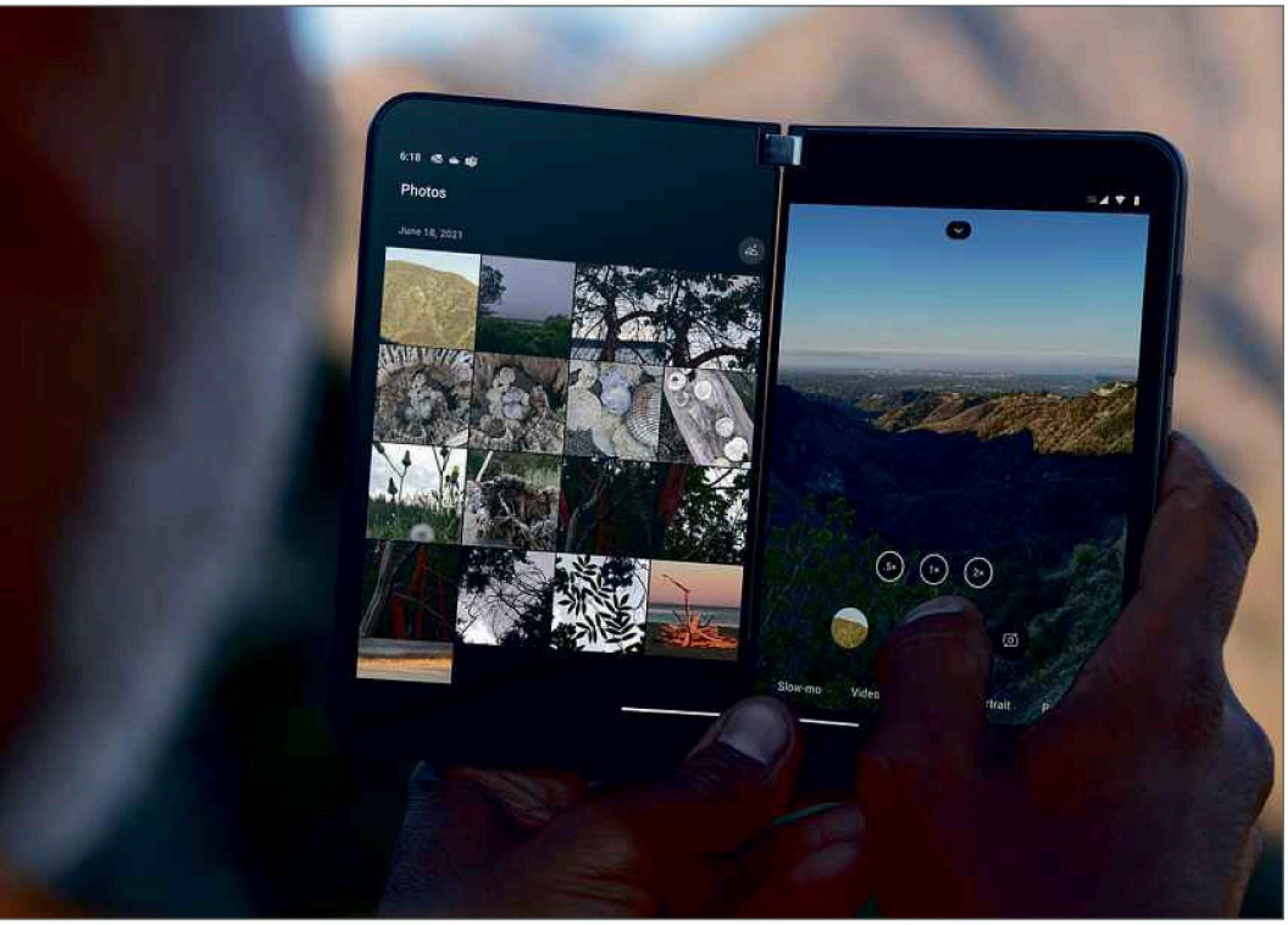
"A reservation list is almost like a VIP list at a nightclub"

BELOW It makes things easier if all your IP phones are in the same range

Why would you want to do this? For lots of reasons. Coming back to the concept of infrastructure on your network, it makes sense for known devices to be given such a fixed address from the DHCP server. It means you can control the numbering on a per-device-type way. So, your router might be 192.168.1.1. Your printers might be in the 192.168.2.x range. Your IP telephones might all be in the 192.168.3.x range. Each of these ranges gives you over 250 IP addresses to play with, which is probably enough to be getting on with.

By doing this, you know immediately that any traffic involving, for example, a 192.168.3.x IP address must be one of the IP telephones.

All infrastructure should be handled this way. On smaller networks, you might even do this for all laptops and mobile phones. This leads to the obvious question: if you do this for all infrastructure, then what's the point of the normal DHCP range? Well, any new device that connects to the network will get something from that range, so they're easy to spot.



ABOVE The Surface Duo: no updates, no confidence, no new purchase

And much easier to spot than in the middle of an ocean of DHCP-assigned variable IP addresses.

In conclusion, it's worth getting to know and love your DHCP server. They usually work just fine, and the defaults are usually sufficient. However, when something goes wrong, you need to know how to handle it. Getting in there and learning what's going on, preferably by setting up fixed allocations for infrastructure, is an excellent opportunity to get ahead of the curve. It makes network fault finding so much easier and obvious, too.

Surface Duo fiasco

So we are now well into 2022 and there's still no Android 11 update from Microsoft for the original Surface Duo. The Duo 2 shipped late last year with Android 11 preinstalled, and it has already received a big update in early December. But, despite promises that Android 11 would ship by the year end for us Duo 1 customers, it hasn't happened.

Allow me to remove my velvet glove and reveal the iron fist within. Microsoft, this isn't good enough. You must publish your roadmap in the public domain, and then you must stand by it. The most Microsoft would say, when pushed by *Windows Central* in early January, was: "we needed a few more weeks to ensure a great experience for Surface Duo customers". Not good enough.

I said on the *PC Pro* podcast that I wouldn't consider buying a Duo 2 until the Duo 1 got Android 11 support. I think that can now be reduced to a simple statement of: "I simply wouldn't consider buying a Duo 2." There, all sorted.

Version numbers

I'm getting tired of companies' version numbering. You might think that this is just me being grumpy, but let me give you an example: my LG monitor has an app for updating its firmware. Let's overlook the mind explosion caused by the concept of updating firmware on a monitor, and move swiftly on. According to the app, the monitor software version is "3.04,2.23,5250,4.13,0.3,43,6.59". Fortunately it appears to be up to date, according to the app, although how I could tell that myself is a mystery.

Now does anyone actually know what any of this spaghetti means? Is it a set of multiple version numbers, all scrunched together? Or some code that means something special to passing aliens? I have no idea, and I'm guessing it means nothing to you either.

Of course, I'm a big fan of version control systems and other similar tools. Checking in code, maintaining a controlled workflow, all of these things are very important. But over the past few years, it seems to be the new normal that whatever internal code numbering is used is splatted out to the customer. Can we please revert to standard numbering? What's wrong with 2022-V2? And then 2022-V3? Let's really push the boat out and have 2022-03-15-V3, although I guess some will whine that it's not obvious whether it's the American or UK date system. Either way, anything must be better than the nonsense of "3.04,2.23,5250,4.13,0.3,43,6.59".

Where do you VPN tunnel to?

There's a rising desire to use VPN tunnels. This is understandable: it allows you to get your traffic out of a potentially toxic local environment to a more trusted space. Such a local environment should be anything where you can't know what is going on with the connection. For example, if you're sitting in a coffee shop and make a connection to a 4G or 5G service, then it's pretty likely that your connection is robust. It takes a lot of equipment to "man in the middle" of that radio connection – it's possible, but well outside the scope of the typical scrote hacker.

Now switch to a coffee shop environment, which sits in an entirely different risk space. If it's a well-known chain, then the IT is probably centrally managed and the local staff have little access to it. Not so if it's a smaller enterprise, where the IT and customer Wi-Fi service have most probably been lashed

BELOW Running a VPN tunnel in a small coffee shop is probably a good idea

together. Our hacker could easily set up a spoof SSID or even find his way into the router's admin area. In a coffee shop like this, or similar, I would definitely run a VPN tunnel to somewhere trusted.

And make sure that all traffic goes via the VPN tunnel, not just some of it. Look at the settings carefully.

This raises the obvious question of "what is a trusted end point for a VPN tunnel?" Well, there are various companies that provide this sort of service, often as part of a computer security or antivirus package. It's likely that their endpoint is reasonably secure, but they will see all of the traffic that goes through their endpoint. This is why the VPNs group test in last month's magazine (*see issue 329, p78*) went to such lengths to talk about each company's reputation.

Of course, they won't be able to look inside your encrypted traffic (for example, any HTTPS to your banking, shopping and other sites), but they will know where that traffic is going on to. This can be interesting data-mining information that can have significant value.

Personally, I prefer to take the belt and braces approach and VPN tunnel back to one of my own networks. If you home is your fortress, and has door locks, outside lights and an alarm system, then you should treat your home network as an equally important secure space. So tunnelling back to your home (or office) network is the most preferable solution. Obviously, you don't want to VPN tunnel into the work network for MegaCorp Limited if you're going to do something dubious on your computer. The separation of work and home is important to recognise.

Setting up VPN tunnels is frankly way too complicated and geeky. Even tools such as OpenVPN can't hide you from the horror that lurks within the configuration pages of most routers. And getting this wrong is really not an option.

For that reason, I'd recommend that you tether to your phone and connect out via 4G or 5G. Although a VPN tunnel has a nice geeky ring to it, the reality is that a 4G/5G connection is robust and secure enough, and much easier to use.

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PAUL OCKENDEN

"If this month's useless metric is 10% higher than last month's useless metric, it's still useless"

Paul delves into the imprecise world of measuring website effectiveness. If you think increasing page views are the secret to success, read on…

Last month I wrote about making sure your website measures up from a technical point of view. This time I want to look at some of the other important metrics, and in particular how to measure your website's effectiveness.

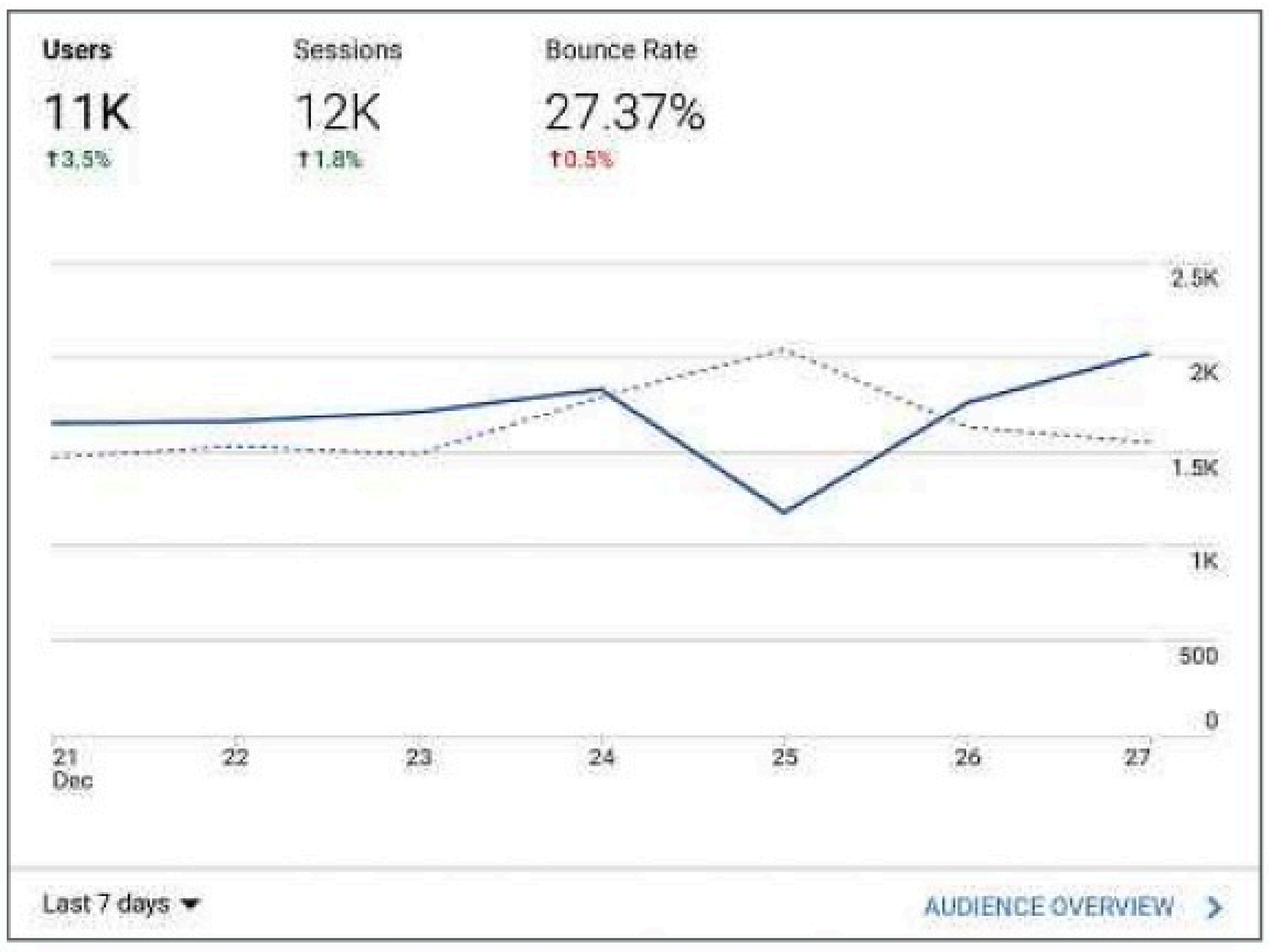
There isn't a one-size-fits-all technique for this, as all websites are different. What I do know is that most people aren't measuring things correctly. I've been a guest in many marketing meetings in large companies where the same old stats are presented month on month: "We had *so many* page views this month, and our busiest page was *this one*. Our site is performing *whatever* per cent better than last month. And we've had *this many* visitors to the site." It's probably all stuff they've pulled from the landing page of Google Analytics, but it's just meaningless rubbish. It tells you nothing about what you really need to know about your site.

Paul owns an agency that helps businesses exploit the web, from sales to marketing
@PaulOckenden

"Page views are a metric of sorts, but not a particularly useful one"

Let's pick it apart bit by bit. First, page views. Yes, they're a metric of sorts, but not a particularly useful one. It's better than "hits", which was the metric that was used a few years back, until people realised it's little more than an anagram. But with page views, just because someone landed on your website, does it mean they found what they were looking for? Page views is purely a measure of quantity, there's no indication of quality. We can't tell whether the visitor bought something, applied for a job or found some useful information. Perhaps they just landed on your website by mistake because your page uses the words in their web search. Or maybe they thought it might be an appropriate source of information, products or services, but they didn't find what they were looking for.

BELOW **Many people rely on basic Google Analytics for their website metrics**



Users
11K
↑3.5%

Sessions
12K
↑1.8%

Bounce Rate
27.37%
↑0.5%

By way of analogy, think about a large out-of-town shopping complex, such as Westfield or the Trafford Centre. The measure of whether the place is having a good day or not isn't the number of people crammed into the walkways, because those people might not be spending. No, the true measure of a successful trading day is the number of carrier bags on view. Loads of people and no bags isn't a good day. Fewer people all loaded up with stuff is much better. When it comes to websites, measuring page views is like measuring people in the shopping centre without taking any account of the bags. Lots of page views doesn't mean your website is a success, but many marketing people just don't get that, and continue to create digital strategies that try to maximise page views.

To an extent it isn't the marketing folks' fault, it's usually the "higher ups". I know the marketing director for a large UK consumer company (I'm going to have to be careful not to identify them here!) who has increasing website page views as one of her KPIs. She knows it's a rubbish metric, and she's tried to explain this to her seniors, but without success. So she tasks her digital team with maximising clicks rather than increasing sales. Actually, because she has integrity, she gets the team to create campaigns that maximise both clicks and sales – it keeps the board happy and allows her to sleep at night.

The only exception to the "page views are a useless metric" rule is if your website carries third-party advertising. In that case, clicks are exactly what you ought to be chasing.

ABOVE **Page views are like counting people instead of carrier bags**

But of course this practice gives rise to misleading headlines and other forms of clickbait, and I'd hate to think that anyone who reads this column would run a website like that!

Let's get busy

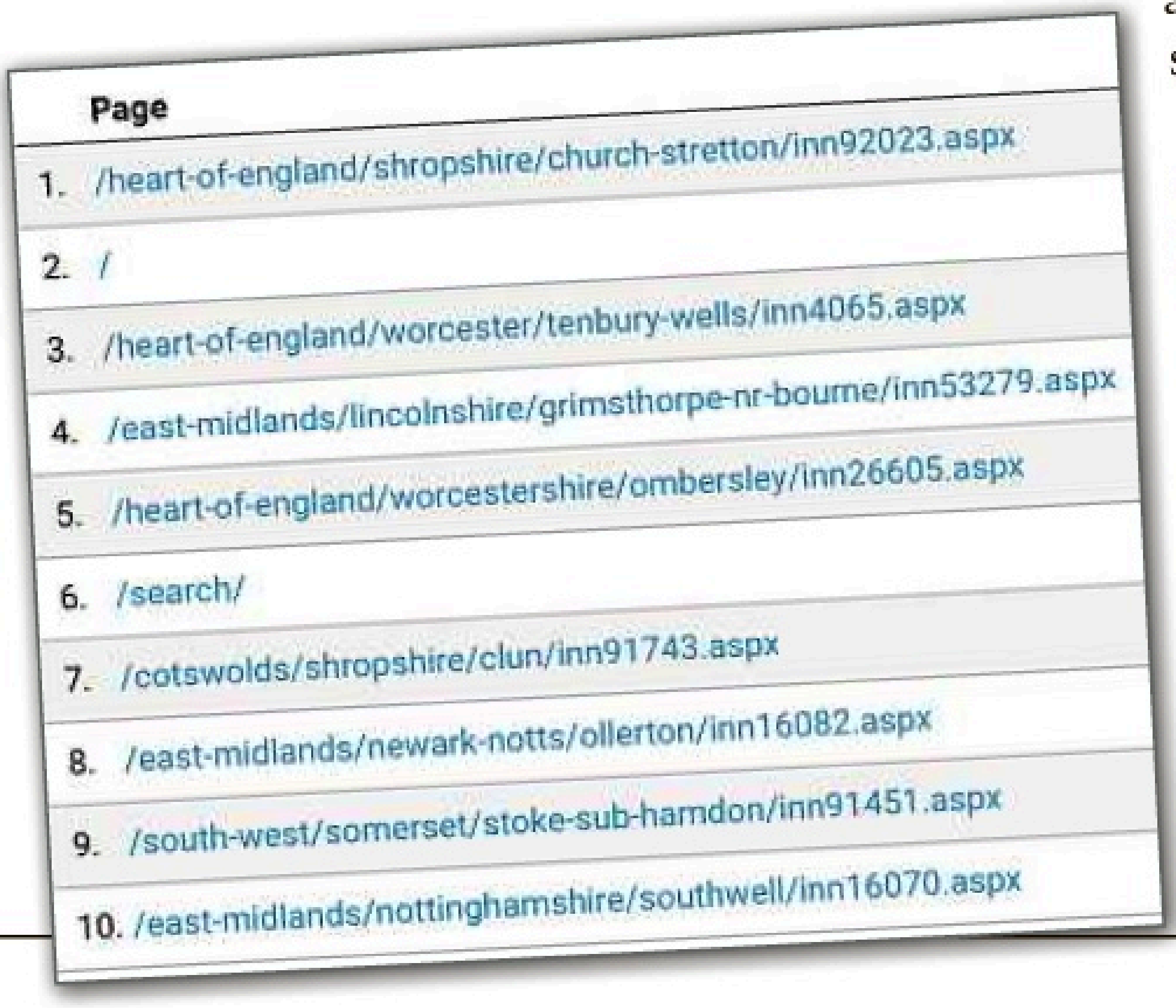
Next up, the busiest page, most probably presented as a list of the 20 busiest pages. What does that mean? What is this list actually telling you? Imagine you are a washing machine manufacturer; does the fact that one model's web page is busier than the others mean there's a lot of interest in that model? Maybe. But it could also be that the people who've bought that machine are having trouble with it and are looking for help online. It's the same with other types of websites. I once sat in on a meeting reviewing a recruitment website. The HR people were chuffed that one of their vacancies was getting a huge amount of traffic. While the person in front of the screen was crowing about their success, I was doing a bit of research using my phone and discovered that the "successful" web page contained a very rude typo and as a result had been linked to from various forums and social media groups. There were some very red faces around the table when I pointed this out.

The other thing about these "top pages" lists is that they are fairly self-selecting. Your page on one topic might be equally as good as the page on a different subject, it's just that the one further up the list gets more traffic. Not necessarily because the page is better; there can be all kinds of reasons. It might contain different search terms (see last month's column), or maybe there's a link to a product from a reviews site. In the latter case, though, it could either be people clicking to buy the product that got such a good review or perhaps folks checking out the absolute turkey that got a one-star review. Again, the raw numbers tell us nothing. As metrics go, it's about as useless as page views.

What about comparing how well your site did compared to last month? Again, that's a certain amount of nonsense. First, what are you actually comparing? As we've seen, things like page views are fairly meaningless. If this month's useless metric is 10% higher than last month's useless metric, then it's still a useless metric.

More importantly, even if you do compare a reasonable data point – perhaps orders for a retailer or table bookings for a restaurant chain – monthly values don't make for a great comparison. Both of these scenarios are likely to see seasonal variations. A toy retailer will see a sales increase in the run-up to Christmas, a restaurant chain will see the same, but also spikes for things such as Valentine's Day and Mother's Day. Just blandly trotting out month-on-month variations will be pointless for many websites: you need to understand the periodicity embedded into your sales data (probably annual, but not always), and then do the comparisons on that basis. This year's February restaurant table bookings make much more sense compared to last February's rather than this January's.

The comparison period thing doesn't just apply to sales or bookings; loads of website stats will have something similar embedded. Accountancy and payroll providers will see peaks in enquiries around the end of the tax year. Holiday providers will see peaks during the school holidays, especially the summer. Gardening product suppliers will have their own seasonal sales patterns – potting compost in the spring, hedge trimmers in the autumn. New car sales will peak around the two annual number plate change dates. The list is endless, and the data will be different for every site.



ABOVE **A list of your top ten pages doesn't really give you any useful information**

	Page
1.	/heart-of-england/shropshire/church-stretton/inn92023.aspx
2.	/
3.	/heart-of-england/worcester/tenbury-wells/inn4065.aspx
4.	/east-midlands/lincolnshire/grimsthorpe-nr-bourne/inn53279.aspx
5.	/heart-of-england/worcestershire/ombersley/inn26605.aspx
6.	/search/
7.	/cotswolds/shropshire/clun/inn91743.aspx
8.	/east-midlands/newark-notts/ollerton/inn16082.aspx
9.	/south-west/somerset/stoke-sub-hamdon/inn91451.aspx
10.	/east-midlands/nottinghamshire/southwell/inn16070.aspx

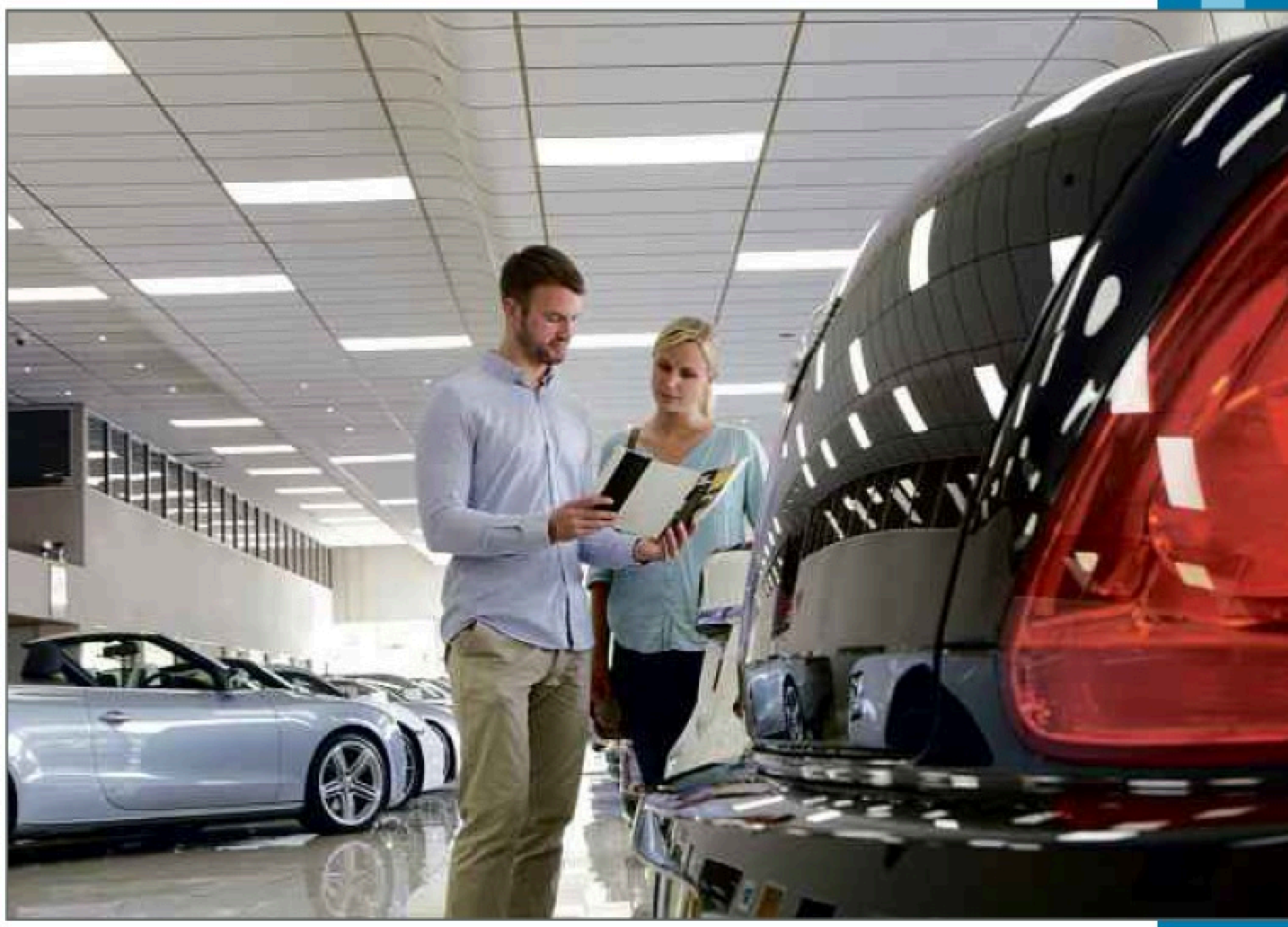
"You can't rely on the visitor numbers churned out by analytics systems"

Visitor numbers

Finally, what about the number of visitors to the site? Well, possibly more so than all of the other stats that we've looked at so far, you really can't rely on the visitor numbers churned out by the various website analytics systems. The one exception is if you have a closed website – perhaps a forum – where users need to be logged in to do anything. But in that case you already have good metrics in the form of posts and reads. For all public access websites, the lists of visitors, new visitors and returning visitors need to be taken with a massive pinch of salt. If your analytics system says that you received 325,327 visitors last month, I'm here to assure you that you didn't, and it really annoys me that website stats systems present numbers in this way. Around 300,000 is about as close as you'll get.

The problem is that visitors and returning visitors calculations use a variety of factors to determine the number, including IP addresses, cookies, browser profiles and server-side session management. So if I look at a website from my office PC, then look again later on my phone, and finally have a quick look on my iPad in the evening, I'll be seen as three visitors. Then take into account that things such as IP addresses and cookies are seen as "tracking" data, and so many people run software that aims to block or obfuscate such data that it quickly becomes apparent that any visit or visitor data will be extremely unreliable and will become ever more so, as anti-tracking becomes more prevalent and increasingly sophisticated.

I'm jumping a bit ahead of myself here, though. Let's take a step back. How should you evaluate the effectiveness of your website? Clients always want to know how to judge their site, but usually ask the wrong questions, hence the page views, lists of top ten pages and visitors.



ABOVE It should be easy to show the effect of a website on a car company's bottom line

If we know that they're nonsense, what else should we be measuring?

Even if we could get, say, an accurate number of visitors to the website, what would it mean? It would certainly mean that you aren't presenting bogus numbers in the marketing meeting, but then someone might ask you an awkward question. Something along the lines of, "So, we've had 325,327 people visiting our website this month. What does that mean? Are we getting a return on our investment? Is the website beneficial to the business?" The correct answer is: "Sorry, from those visitor numbers, I just don't know."

The metric system

There are three main measurable metrics for most websites: traffic, actions and feedback. Everyone seems to be fixated with traffic, because it's easy(ish) to measure(ish), and it gives nice big numbers. But as we've seen, it's a useless measure of website effectiveness. So what about actions?

This is the most important metric by far, and it's all about measuring the user doing something on your site. On an e-commerce site it will be them buying something – that one's easy to measure. As long as the e-commerce system is properly integrated into the company's accounting setup, it should be possible to know the exact value of sales (and profit) that are directly attributable to the website. Given your annual spend on things like licences, hosting, development and maintenance, it should be possible to subtract this from the online profit and so determine the exact input that the website has to the company's bottom line. That effect on the bottom line is the most important metric you can get for your website, yet it's one that you'll hardly ever see come up in marketing or digital strategy meetings.

What about brochure-ware sites? How do we measure the bottom-line impact of those? It's possible, but not as easy as it is with pure sales-based sites. The key here is to have a good customer relationship management (CRM) system driving not just the website, but the whole business.

Let's take the example of a car manufacturer. A visitor to its website might request some information or a brochure; then a week later they take a test drive at their local dealership; and then a month after that they buy a car. It should be possible to tie all of these events together by looking at the person's name and address. Although you can't attribute the profit on the sale entirely to the website, it should be possible to compare the sales conversion data for those visitors requesting a brochure via the website to those who don't. Again, this can be extrapolated to show the effect that the website has on the company's bottom line.

What about cases in which no sales are involved? I've mentioned before that my company does a lot of work on recruitment websites and associated things such as pay-per-click campaigns. Most recruitment websites include a list of vacancies and a job application form, and from this it's usually possible to calculate a cost saving. Simply take the average cost for recruitment via traditional channels (agencies, newspaper ads, etc), and multiply that figure by the number of people recruited via the web. Then compare that with all the costs of running the site, including any PPC advertising: the difference is the value contribution from the website towards the bottom line.

The same logic can be applied to technical support sites. You'll know how much time you spend, on average, helping a customer if they get on the phone or open a ticket. In both cases there's staff wages, covering the frontline support staff and maybe higher level engineers. So if you determine your most frequent support subjects and create easy-to-find online help for those problems, it should be easy to determine the reduction in calls and tickets and again calculate the benefit to the bottom line.

Being able to directly attribute the effect of the website on the company's profit margin is always going to be the best way of calculating the effectiveness of the site, but it won't always be easy. Sometimes you'll need to think outside the box, or build measurability into your promotions and communications channels.

The final measurable metric is feedback. There are two things here: the feedback about the site itself, and the feedback about your company's products and services. Although feedback about the website is both important and interesting, it's self-referential. The place where you can really look to add value is by analysing the feedback about your output. Again, this breaks down into two separate elements. First, there's general feedback about quality. Bear in mind that if ten people have a lousy experience, then between five and seven will complain, whereas if ten people have good service then perhaps one will offer praise online. These are generalised figures and will vary across different sectors.

"There are three main metrics for most websites: traffic, actions and feedback"

BELOW Measured correctly, you can see the effect of your site on company profits

Let's say you run a chain of off licences and lots of complaints come in about one branch – staff allowing underage sales, perhaps, or gangs of kids hanging around outside, stuff like that. This will be detracting some genuine customers from visiting the branch and so will be affecting sales. Putting in a more "robust" manager to look after the branch should help, and you ought to be able to see the "before" and "after" effect on the branch sales figures. If it wasn't for feedback via the website, you probably wouldn't have noticed the problem until the branch got a closure notice from the authorities following an underage test purchase.

The second way you can use the feedback is for general product or service research. You can directly compare the costs of your website feedback to other research methods such as panels, focus groups and online surveys, and again calculate the saving.

In summary, next time someone tells you how many clicks their website gets, or how many eyeballs it attracts per month, ask them how much that contributed to the company's profitability. And if they don't know, you can tell them from me they're measuring the wrong stuff.

@PaulOckenden

LEE GRANT

“Are there really that many young blonde women who want to hook up with a septuagenarian?”

Don’t be offended if Lee seems to be ignoring you. It’s one of the talents he’s developed when dealing with delicate matters while repairing clients’ PCs

Working through the pandemic has convinced many of my clients that remote support is a great option. Repairers have also adapted their methods, especially a skill that is seldom discussed: the art of ignoring things that the client definitely didn’t want anyone to see.

The most common example would be a client demonstrating a browser quirk, where one innocent keystroke displays their recent history. Via the magic of remote, I can quickly redirect with chat about fascinating icons in the taskbar while triggering incognito mode so we can both move on.

Last November, I didn’t have the barrier of remote software when I was unblocking a customer’s email client. My solution to his problem is no technical marvel – all that was needed to get things running was a decent internet connection – but even with awful broadband, email blockages are more Outlook Express circa 2004. The problem was a staggering amount of messages from a charming website called shag2night.com which, I was surprised to discover, is not an on-demand tobacconist but a “social platform for men and women who are looking for fun, flirty contact”.

Let’s be clear. It’s none of my business if this customer has platinum memberships to sites offering every (legal) proclivity known to mankind, but he was genuinely mortified. His wife thought it was hilarious. He claimed to have no knowledge of how his email address had ended up on the company’s mailing list and, on that point, I couldn’t comment. I do have questions about the data segmentation used to match my client to the throng of ladies seeking a meaningful night of no-strings commitment. Why were all their names random text strings? Are there really that many young blonde women in my area (the customer lives nearby) who want to hook up with a septuagenarian? Where do they park the Lamborghinis that adorn their profiles, as I’ve not seen any at Morrisons? I advised the client on how to contact the company’s support team. A classic case of things the client definitely didn’t want me to see.

Lee Grant and his wife have run a repair shop in West Yorkshire for over 15 years

@userfriendlypc

“Where do they park their Lamborghinis, as I’ve not seen any at Morrisons?”

Spam, spam, spam

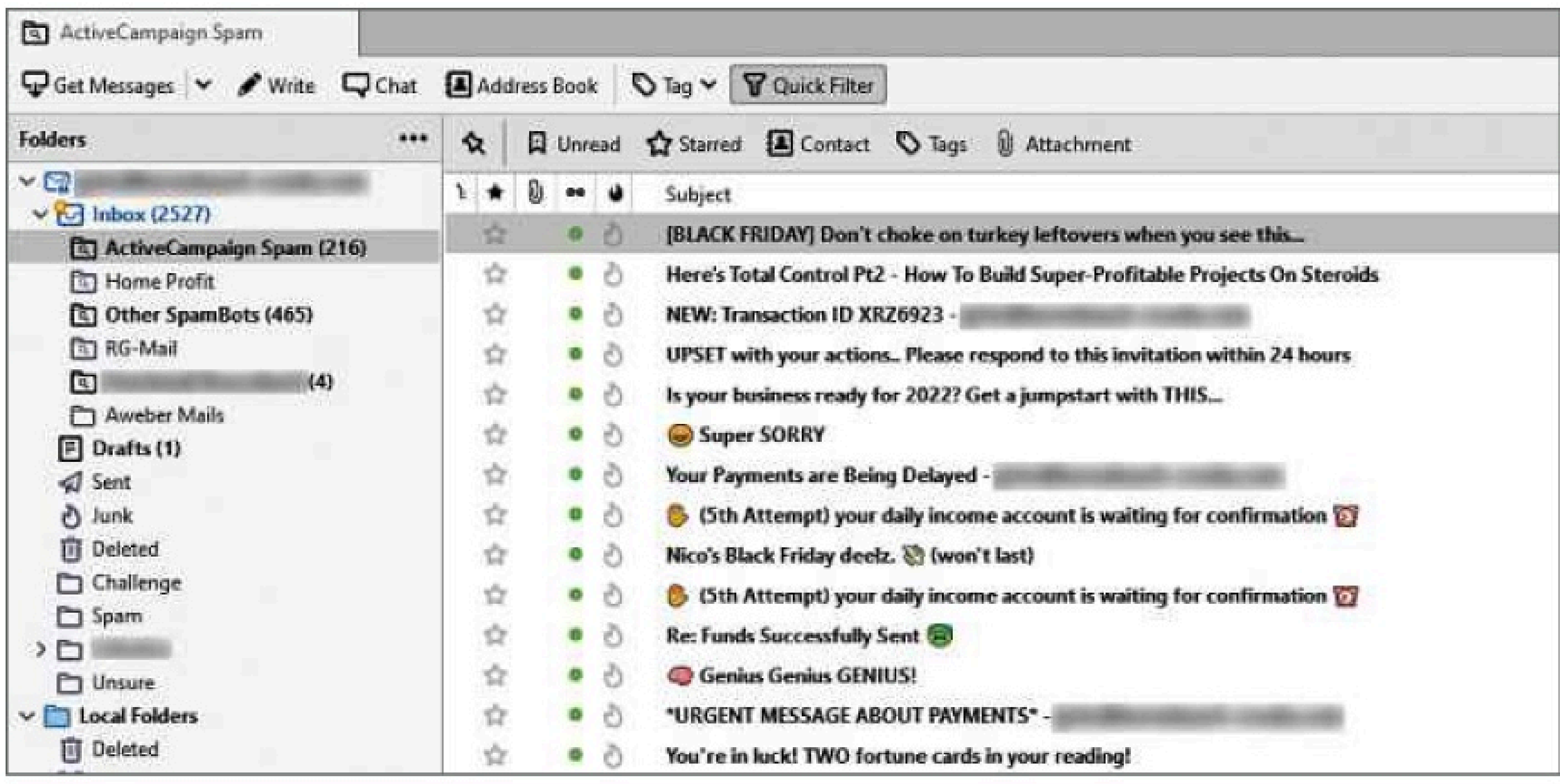
As part of my job, I routinely dig around inside the email accounts of clients and I’m staggered by the vast volume of unsolicited mail that still permeates through top-notch spam filters. For many months, I’ve been working to solve a spam issue in which conventional methods are inappropriate. Joan (which is in no way her real name) is a one-woman limited company with a well-earned reputation in a niche field of medicine. She’s working hard to wrap up the company and offload her high-profile clients before her retirement, which has been hastened because of a diagnosis of early-onset dementia.

When I started, she was receiving around 800 junk emails a day, and spotting the genuine business correspondence was impossible. We tried various anti-spam programs and filters. These were successful for a while, but as Joan’s condition worsened, her ability to manage software solutions also deteriorated. Establishing who would be contacting and when was unclear, so solutions involving forwards or replacement addresses were out. I decided to treat cause and symptom.

I built a list of Message IDs contained within the email headers (Message ID shows the domain of the email’s origin) and this gave me a target list of commercial mailing providers whose systems were being used to spam Joan. A few exchanges with AWeber Communications (**aweber.com**) resulted in: “I just unsubscribed your client from all AWeber-powered lists where they were a subscriber. I also globally blocked them from our system as well.” Fabulous! Net Atlantic (**netatlantic.com**) and many others were just as helpful and the volume of received junk dropped.

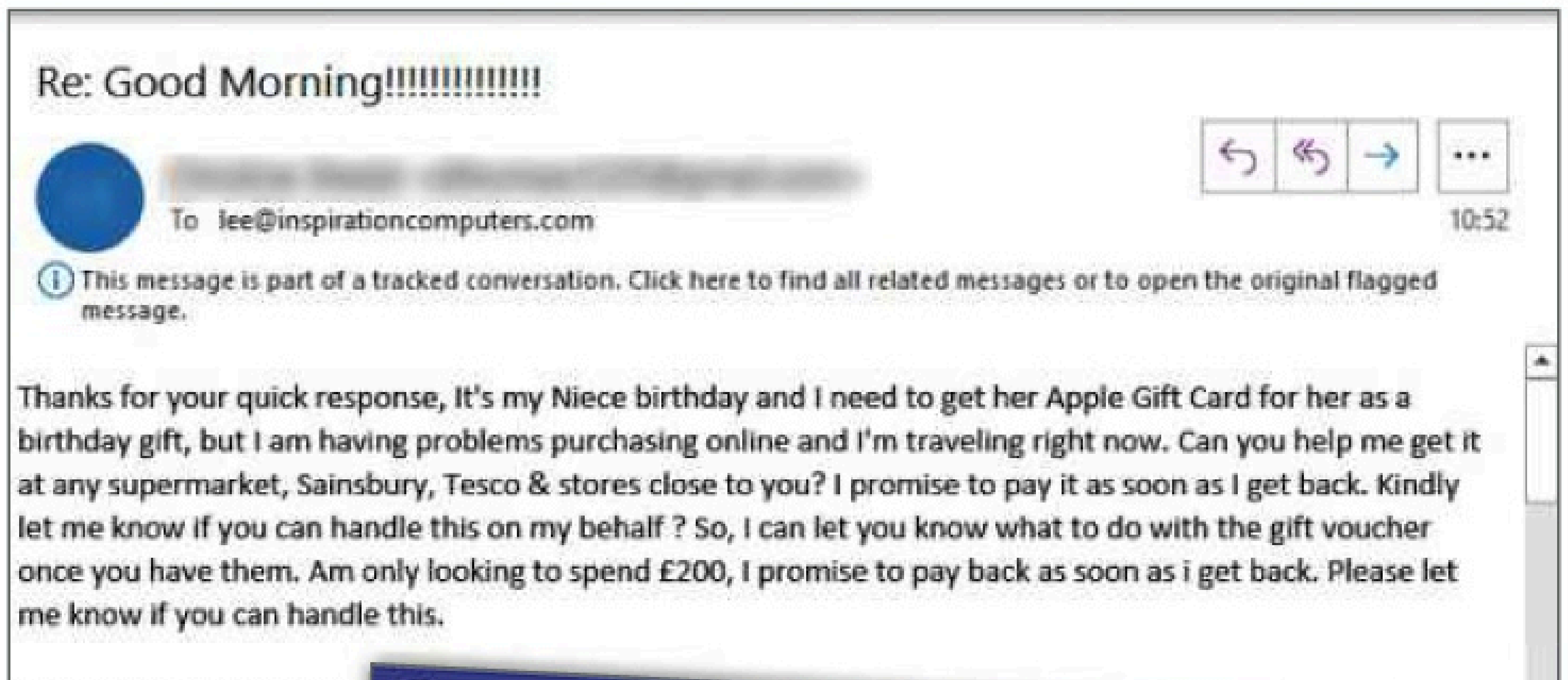
Some of the most frequent abusers of Joan’s inbox originated from ActiveCampaign’s platform (**activecampaign.com**), and its response was very different. “Unfortunately, we do not have a way to block the user on a global platform level since each customer manages their subscribers on their own. This is not ActiveCampaign that sends the emails but the customers.” Nope, this didn’t impress me either, so I pushed back, asking it to clarify why it couldn’t block Joan’s address from its platform. “We don’t have that functionality to override our system as it is beyond our control.”

The worst offender in Joan’s inbox was Homeprofitpoints (**homeprofitpoints.com**) which, at one point, was responsible for 50-60% of her daily spam. Its website has an unsubscribe page (which made no difference) and a privacy policy with no contact details. Other offenders were even more untouchable, so I vowed to make their life a misery by filing complaints with their hosts,



[BLACK FRIDAY] Don't choke on turkey leftovers when you see this...
Here's Total Control Pt2 - How To Build Super-Profitable Projects On Steroids
NEW: Transaction ID XRZ6923 - [redacted]
UPSET with your actions.. Please respond to this invitation within 24 hours
Is your business ready for 2022? Get a jumpstart with THIS...
Super SORRY
Your Payments are Being Delayed - [redacted]
(5th Attempt) your daily income account is waiting for confirmation
Nico's Black Friday deelz. (won't last)
(5th Attempt) your daily income account is waiting for confirmation
Re: Funds Successfully Sent
Genius Genius GENIUS!
URGENT MESSAGE ABOUT PAYMENTS - [redacted]
You're in luck! TWO fortune cards in your reading!

RIGHT Despite all the tech advances in recent years, spam is still a major problem



Re: Good Morning!!!!!!!!!!!!!!

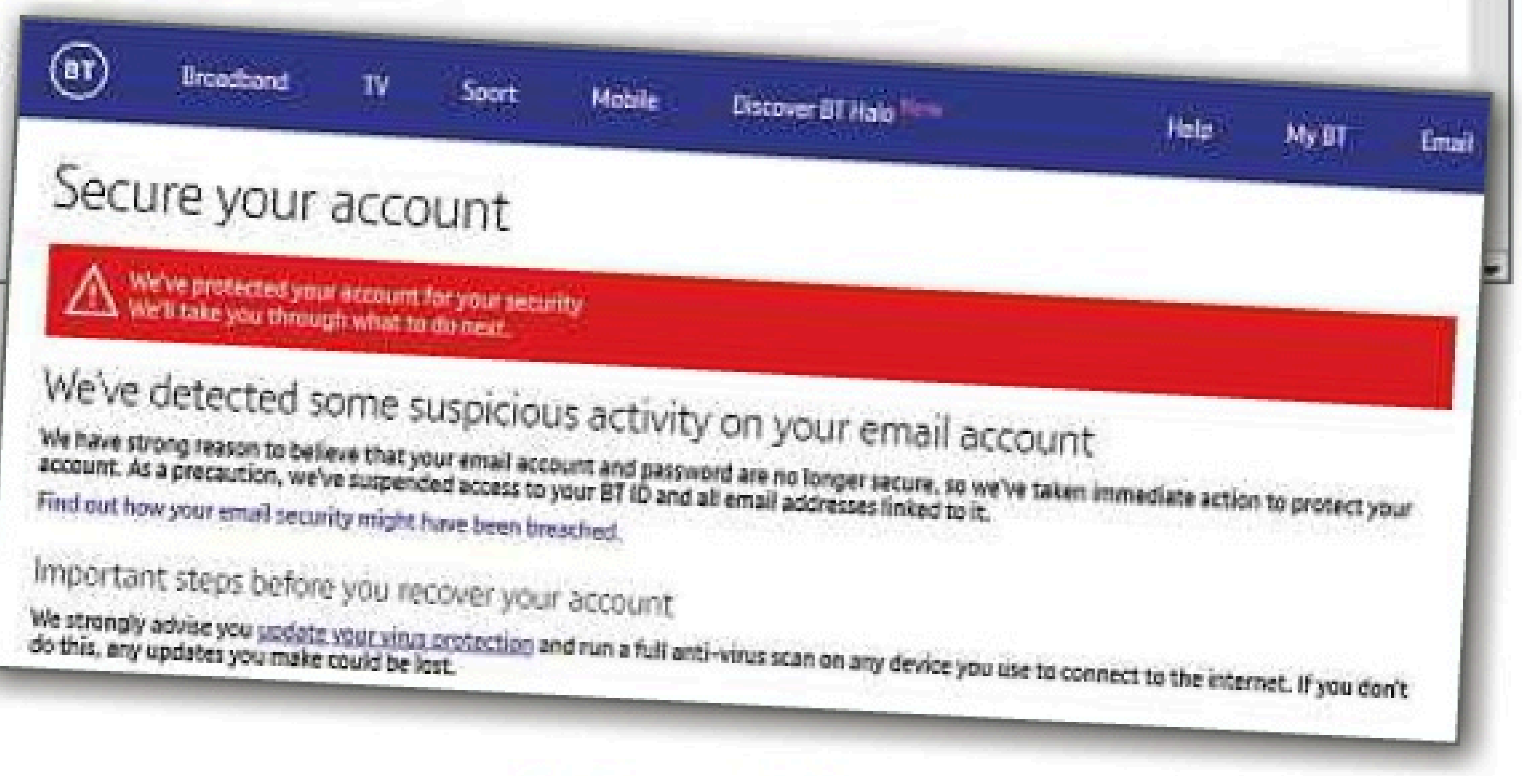
[redacted]
To lee@inspirationcomputers.com
10:52

This message is part of a tracked conversation. Click here to find all related messages or to open the original flagged message.

Thanks for your quick response, It's my Niece birthday and I need to get her Apple Gift Card for her as a birthday gift, but I am having problems purchasing online and I'm traveling right now. Can you help me get it at any supermarket, Sainsbury, Tesco & stores close to you? I promise to pay it as soon as I get back. Kindly let me know if you can handle this on my behalf ? So, I can let you know what to do with the gift voucher once you have them. Am only looking to spend £200, I promise to pay back as soon as i get back. Please let me know if you can handle this.

Awaiting your kind reply.

Regards,
[redacted]



Secure your account

We've protected your account for your security
We'll take you through what to do next.

We've detected some suspicious activity on your email account

We have strong reason to believe that your email account and password are no longer secure, so we've taken immediate action to protect your account. As a precaution, we've suspended access to your BT ID and all email addresses linked to it.

Find out how your email security might have been breached.

Important steps before you recover your account

We strongly advise you update your virus protection and run a full anti-virus scan on any device you use to connect to the internet. If you don't do this, any updates you make could be lost.

ABOVE BT has some odd ideas about what constitutes suspicious activity

registrars or Ant and Dec if it would make a difference.

My other attack strategies included using Mozilla Thunderbird's "Saved Search" feature to filter Joan's email via Message ID and Return-Path. Microsoft Outlook doesn't have this ability, and it proved more successful than the expensive anti-spam tools that seemed to look in the other direction. We also brought Joan's email under the control of our web host, 20i (**my.20i.com**), to filter things out before they hit any email client.

The great news is that we squashed the spam to manageable levels and Joan happily concluded her business affairs before she unexpectedly passed away just a few weeks ago.

This case also fits into the bracket of "things the client definitely didn't want me to see". Joan was one of our first customers, and although we'd spent hours together as I fixed glitches over the years, I don't think either of us ever imagined that I'd be digging through her private emails as she approached the end of her life. The level of trust she placed with us humbles Alison and me, but it's hard not to feel anger at the frustration of this whole situation.

Why is spam still a problem? AI can now DeepFake actors into movies made years after they died, but we still can't prevent inboxes filling with crap! Why has Microsoft abandoned the spam tools on its email software? Outlook is meant to be industry leading, but without third-party or server-side intervention, it's as useful as a chocolate hairdryer. The Mail app for Windows only fares better because its performance is so poor that the chances of it receiving email, spam or otherwise, are negligible. Why does a multi-million pound entity like ActiveCampaign, with offices on four continents, think it's acceptable to run a system that, by its own admission, it can't control?

An answer, some would suggest, is that email is a dead medium and can't compete with instant messaging apps such as WhatsApp, Messenger, QQ and Telegram. If this area of computing tickles your toes, then I heartily recommend How To Fix Email... With Science! (**wired.co.uk/article/how-to-fix-email-science**) written by our own Nicole Kobie.

Email hack attack

Last summer, I received an email from Jeremy asking me if I could do him a favour. I replied asking how I could help and was asked to buy an iTunes gift card as an emergency present for his niece: "am only looking to spend £200, I promise to pay back as soon as i get back". Naturally I called him with the great news that his email account had been compromised. How did I know? The first email came from Jeremy's btinternet.com address, but the response came from dthomas1225@gmail.com. I wasn't the first to sound the claxon, but Jeremy's chief concern was for the people who'd already called him, wanting to deliver the gift cards. Yes, people do really fall for this one.

Jeremy had been stupefied by the incident and sort of hoped that the problem would go away on its own, but scams don't work like that and are designed to run riot and drain bank accounts until something spoils the fun. I advised Jeremy to change his password, but an hour later he was in the shop looking rather worried as people were still receiving email from him. His laptop was coming my way.

I logged into his BT account, which was helpfully displaying a bright yellow banner warning that Auto-Forward was now sending messages to dthomas1255@gmail.com. The message finished with an ironic flourish, "For help, visit https://www.bt.com/secure".

That's how this scam works. Email account is compromised, auto-forward is set up and phishing mail sent to every email address in the account. Replies are then auto-forwarded to the scammer's address for the mayhem to continue.

Jeremy didn't see the yellow banner as he uses an iPad for email. He doesn't recall receiving an email warning or confirmation request for the auto-forward, but that's probably because the scammer took care of it. I removed the auto-forward, switched on 2FA, then logged out to show Jeremy how it worked. His BT account now displayed a red banner. "We've detected some suspicious activity on your email account." Really? Switching on 2FA is suspicious, but setting an auto-forward before emailing the entire address book at 1am isn't! "We've suspended access to your BT ID and all email addresses linked to it." Bravo BT, slow hand claps all round. We'll tag this one as "things the client didn't want everyone they've ever emailed to see".

> **"Scams are designed to run riot and drain bank accounts until something spoils the fun"**

BELOW Don't leave dodgy DVDs in the disc drive for your mum to discover

Slipped disc

Going back quite a few years, a client brought in his gaming rig because the DVD had failed. This wasn't quite true; it was just that a disc had become wedged in the mechanism, and using a straightened paper clip, I got the drawer open and removed the blockage. I showed it to Alison, and we were both quite surprised that people were still buying this genre of movie on a physical medium.

Luckily, we can't print the title of the film in the magazine, but we imagine the synopsis could be that a young couple, newlyweds perhaps, had been trying for a baby without success. One of them must have come up with the wheeze to invite the husband's football mates along for encouragement and, perhaps, some demonstration of certain techniques. We didn't watch the film, but the title suggested that their conception attempts were not being thwarted by effort, or indeed volume, but a misunderstanding of rudimentary anatomy and physi... look, it doesn't really matter.

What's important is that I never want to put any client into a situation that either embarrasses them or makes them feel like they've embarrassed me. I could have put the DVD back in the drive, but I was worried about it moving in travel, so I placed it in paper wallet, taped it to the top of the case and made the call. When his mother came to collect the machine, the first thing she did was rip the tape saying, "what's this junk he's been watching" – at which point she screamed and dropped his machine.

We list this one under "things a client definitely didn't want their mother to see".

lee@inspirationcomputers.com

Guest columnist

OLIVIA WHITCROFT

"How do you launch a product without alienating or damaging your customers?"

Data protection by design isn't a buzz phrase for companies to ignore. It's a principle that should guide you on every step of a customer's journey

Olivia is principal of the law firm OBEP, which specialises in technology contracts, IP and data protection
@ObepOlivia

"Without data protection by design, data protection may only be an afterthought"

Let me tell you a story: you're having a new friend round for lunch. You've designed a recipe for "Meaty Platter", which combines a range of meats. You've bought the finest ingredients for the platter. That morning you blended it together and made it look amazing. Your friend arrives. She takes one look at your beautiful platter and declines to eat it; she doesn't understand what it's made from, and doesn't want to eat meat. Meaty Platter goes in the bin, and your friend doesn't return. Or maybe she takes a taste, and then suffers a severe stomach ache later that day, and your friendship is lost.

So how do you host a lunch without alienating or damaging your friends?

Before designing your recipe, you consider whether aspects of your menu may use ingredients unsuitable for some guests. You could also ask your guests if they have any dietary concerns. Any issues can then be addressed within your recipe. You can prepare a tailored platter with all dietary needs baked into it. You can let guests know what it is, so they can make an informed decision whether to eat it. In my story, you could then present your friend with a meal she understands. Meaty Platter (perhaps renamed to Veggie Platter) hopefully won't be thrown in the bin. If your friend takes a taste, she is less likely to suffer a stomach ache, and you're more likely to retain your friendship.

You may not be able to eliminate every risk. You are unlikely to have considered all potential eventualities, or to have discussed with every guest the full detail of your menu. A guest may have an unforeseen dislike to a particular ingredient, or a previously unknown allergy. But, by considering the risks in advance, and without taking disproportionate steps to guarantee a fault-free meal, you have minimised the risk that a dietary issue leads to your food not being eaten or causing damage to your guests.

The story retold

Let me tell you another story: you're launching a new technology product. You've designed a recipe for "Meeting Platform", which combines a range of information about customers' online habits, to create the perfect meeting experience. Over the past year, you've engaged the finest coders for each component of the platform. You have been blending it all together and making it look amazing. You press the launch button (there's always a big launch button, right?), and your customers enter your platform. They take one look at your beautiful product and decline to use it; they don't understand what you do with the requested data, and they don't want to provide it. Meeting Platform is shelved, and your customers don't return. Or maybe some customers take a taste, and then you suffer a severe security breach later that week, and customer data is lost.

So how do you launch a product without alienating or damaging your customers?

Before designing your product, you consider whether aspects of it may use personal data. You could also ask potential customers if they have any concerns with the use of their data. Any issues can then be addressed in the recipe, and the components that form part of it. You can prepare a tailored platform with data protection needs baked into it. You can let customers know what you'll do with their data, so they can make an informed decision whether to use it. You can then present customers with a product they understand and want to use. Meeting Platform hopefully won't be shelved. If your customers take a taste, you're less likely to suffer a security breach, and you're more likely to retain your customers.

You may not be able to eliminate every risk. You are unlikely to have considered all potential eventualities, or to have discussed with every customer the full detail of the platform's use of personal data. A customer may have an unforeseen dislike of a particular use of data, or the system may have a previously unknown vulnerability. But, by considering the risks in advance, and without taking disproportionate steps to guarantee a fault-free product, you've minimised the risk that a data protection issue leads to your product not being used or causing damage to your customers.

Data protection by design

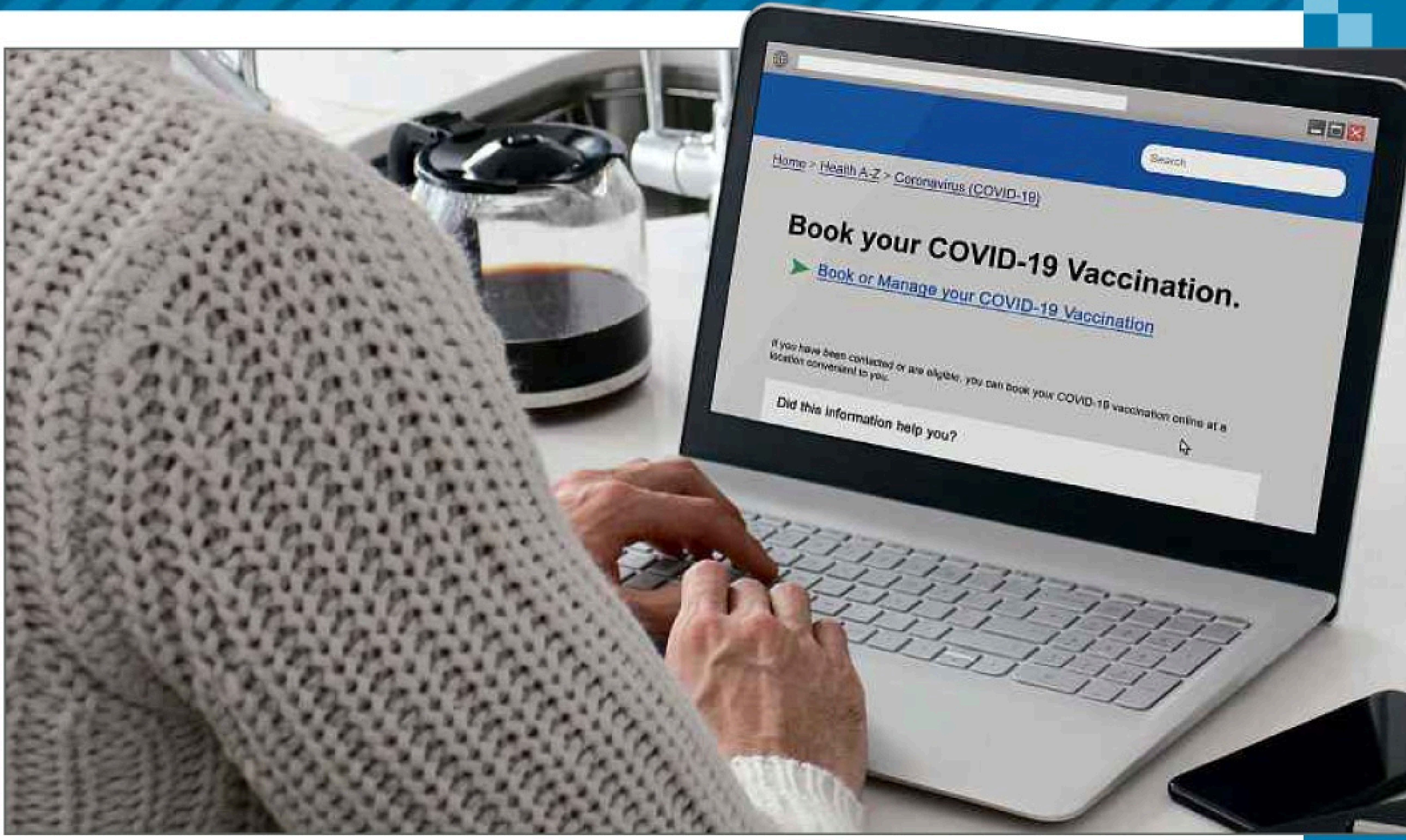
Data protection by design is just this. It is about baking in data protection compliance into the design and development of new activities involving the use of personal data. All data protection requirements should be addressed, including the core principles (such as transparency, data minimisation and security) and enabling individuals to exercise their rights (such as to access and erase data).

Data protection by design is a legal requirement under Article 25 UK GDPR, along with the closely related concept of data protection by default. This requires that the default position for any activity is to collect the minimum amount of data and do the minimum amount of processing. The obligations are ongoing throughout the lifecycle of the use of data.

utomatic Logout
Off
Show My Email Address
On
Anyone Can Message Me
Off
Hide Blocked Members

BELOW **Give potential customers as many options as possible about the use of data**

Without data protection by design, data protection may only be an afterthought for a project (by which time it may be too late to address issues), or it may be ignored completely. This may lead to the project


Home > Health A-Z > Coronavirus (COVID-19)
Search
Book your COVID-19 Vaccination.
Book or Manage your COVID-19 Vaccination
Did this information help you?

ABOVE The NHS is just one organisation to fall foul of data protection concerns

being shelved. As a topical example, the NHS Covid-19 app faced several data protection hurdles. Privacy concerns were key to the government scrapping the original 2020 model. And in 2021, it was reported that an update to the app had been blocked by Apple and Google due to prohibited collection of location data.

Even if a project isn't cancelled, it could cause significant costs and delays to rework it to address data protection issues. In May 2019, the Information Commissioner's Office (ICO, the UK data protection regulator) issued an enforcement notice against HMRC in relation to its Voice ID service, requiring it to delete data. The ICO found that HMRC was processing biometric data (for voice authentication) without a lawful basis under data protection law, as it had failed to obtain adequate consent. In its notice, the ICO stated: "HMRC appears to have given little or no consideration to the data protection principles when rolling out the Voice ID service." In other words, it didn't apply data protection by design.

When is it needed?

Data protection by design most obviously springs to mind for big projects, such as new technology systems that will process personal data. However, its remit is much wider than this. It applies to all activities involving personal data, big or small, and to the preparation of policies and processes that govern the use of data. However, you may not need to carry out the same level of review in each case. As raised in my stories, the approach you take and the extent of measures you put in place should be proportionate to the risks involved.

Consider, for example, a business's use of customer contact details to keep customers updated about requested services. Design measures may include ensuring customer details aren't used for a wider purpose, and are kept up to date and secure from misuse. However, the assessment may be fairly quick, and the measures fairly standard. Compare this with more innovative or intrusive uses of data, such as those involving artificial intelligence or sensitive data, or monitoring and profiling individuals. A more complex assessment and more bespoke design measures are likely to be needed. For these types of higher risk activities, a formal data protection impact assessment (DPIA) may be needed (under Article 35 UK GDPR), and a DPIA forms an important part of data protection by design. Consultation with data subjects (in other words, asking those who will be impacted for their views), is also a stage of the DPIA process.

In my experience, higher-risk projects are commonly now given some quality data protection time. However, I still come across some clangers. Just the other day, a company sent its employees a request to provide their Covid-19 vaccination details, together with proof of vaccination (with type of vaccine and dates), or the reason why they were unvaccinated. The request had no explanation as to what would be done with this information. My head started firing out data protection principles: there was no transparency or specified purpose! What was the lawful basis? How about data minimisation?

At the lower-risk end of the spectrum, I find there is a tendency to focus on specific aspects of compliance (such as having a privacy notice, and checking security measures), without looking at the full range of data protection design elements. As an example, one of my clients recently launched a new website, and included a form for people to sign up to receive a newsletter. However, there was no newsletter – this request was "just in case" the company decided to create one in the future. Data protection by default, and the principle of data minimisation, would say don't collect this information yet, as it isn't needed right now.

> "Data protection by design applies to all activities involving personal data, big or small"

NEWSLETTER
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BELOW Never ask users to provide details you don't actually need

Raising PETs

The organisations actually collecting and handling personal data have legal responsibilities under data protection law. However, product developers have a role in designing systems with data protection embedded, which can also be a selling point for them. This is the aim of "privacy-enhancing technologies", meaning technologies that are designed for supporting specific privacy or data protection functionality, or protecting against privacy risks. They are currently a hot topic in the data protection world.

I have excitedly been trying to understand mathematical concepts such as differential privacy (adding "noise" to statistics to make it more difficult to identify source data), and homomorphic encryption (which enables functions to be carried out on specific data without decrypting whole data sets). Anonymisation and pseudonymisation functionality can also be built into technology design. These types of measures may most obviously assist with information security, but they have wider data protection benefits. They may, for example, limit retention periods by ensuring that individuals can no longer be identified from data sets; ensure that only the minimum amount of personal data is held within a system; and facilitate the exercise of rights by data subjects.

So next time you're designing your recipe for new technology or data-processing activities (or even a meaty platter), don't forget to bake in your data protection (or dietary) requirements.

olivia.whitcroft@obep.uk

DAVEY WINDER

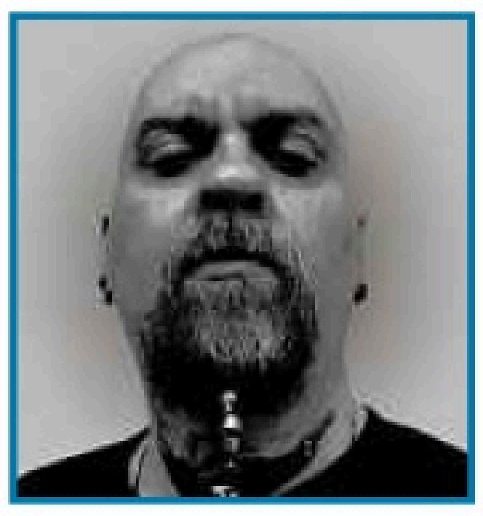
"My advice remains: don't sleepwalk into a data breach, and use a password manager"

Davey reveals the common password traps people fall into, provides a super-duper security enhancement for Edge and slow-claps Google

Regular readers will know I'm somewhat obsessed with threat-intelligence reports; I suck them up faster than a deranged Dyson in a dust factory. One ransomware attack analysis, however, caught my attention recently because of passwords. I skipped over the bit about local admin passwords that hadn't been changed for a year (not least as regularly changing passwords isn't something I advise), and even the fact that they were all the same didn't surprise me much, sadly. No, what grabbed me was the password of `1qazxcv itself.

Kudos to anyone who immediately spots the problem. Unfortunately, far too many people would think it relatively secure. Well, if you ignore the fact it's a meagre eight characters long. Putting the length problem to one side for a moment, adding numerical and special characters into the password construction mix is a good thing, right? Sure, mixing upper and lower cases is also recommended. But none of this reveals the problem with `1qazxcv: to crack this code you need to focus less on the construct and more on the construction.

Take a look at the keyboard and you'll see it's a typical "keyboard walk" password where the characters are all connected within an easy-to-remember pattern. Easy to remember, yep, and easy for an attacker to breach. These kind of pattern passwords are stupidly common within organisations, and that's for admin accounts as well as less privileged users, I should add. The fact that they appear to fulfil common criteria for more secure passwords and are easy to recall makes them particularly dangerous in the hands of those who don't appreciate the usage risk. In precisely the same way that P@ssWord1! appears to be fairly strong to the uninformed eye when actually it's anything but.



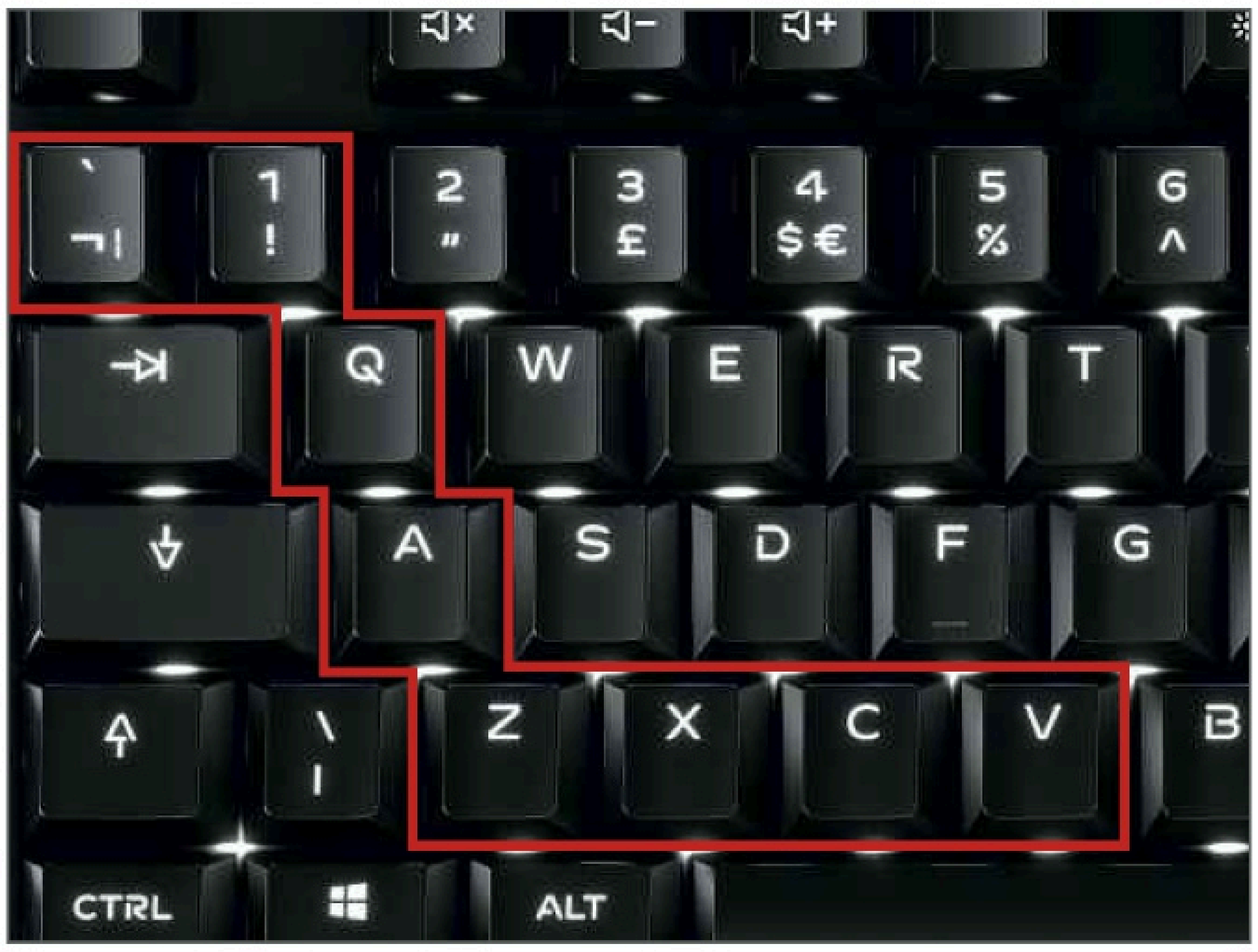
Davey is a journalist and consultant specialising in privacy and security issues

@happygeek

There's a really good infographic in an analysis of 10 million passwords to be found at **pcpro.link/330unmasked**, which details the 20 most used keyboard walking patterns, excluding numerical ones, used for passwords, from the most obvious of Qwerty at number one to adgjmptw at 20.

Hold on, adgjmptw doesn't look like a qwerty keyboard walk at all, so what gives? Think of another keyboard, or rather keypad, we commonly use. Yep, it's the dialling keypad layout of your phone. Or, more accurately, the first letter equivalent to each number if pressed in numerical order. It's still a tad surprising to see this on a top 20 list, to be honest, what with the prevalence of onscreen Qwerty keyboards these days. Stand up if you still send messages using the dialling pad to write them. Yep, you're all still sitting down.

The wpengine password analysis I mentioned earlier thinks it is likely a BlackBerry legacy thing, and that makes as much sense as anything, I reckon. Whatever, the advice remains the same: don't sleepwalk into a data breach, and use a password manager for truly random and strong password construction and recall.



BELOW **A keyboard pattern that's easy to remember is also easy for hackers to breach**

Super-duper browser security comes at a cost

Jon Honeyball (*see issue 328, p111*) isn't alone in switching browser allegiance to Microsoft Edge. I will admit to having done the same, largely for Jon's "being more resource-friendly" reasons, when it comes to my primary browser. Maybe I am somewhat unusual, in that I use a whole bunch of different browsers for different things. So, Firefox remains in daily use, along with Chrome, Safari and DuckDuckGo, but just not for everything I do. I won't get into my specific use cases here as they are both irrelevant and likely to be unique to me. Safari and DuckDuckGo are both platform-specific choices, though – iOS, in case you hadn't guessed.

What I will say is that I keep a close eye on browser security, as you would expect. Chrome had a very busy 2021 dealing with update after update to patch against one zero-day vulnerability after another, which is a good thing in terms of dealing with the threats, obviously. However, 16 zero-days isn't a great look and Microsoft was, I assume, having a dig at this when one corporate vice-president, Liat Ben-Zur, noted in an October 2021 posting about Edge that it was "more secure than Chrome" as well as Firefox, because it offered "better protection against phishing and malware attacks on Windows 10".

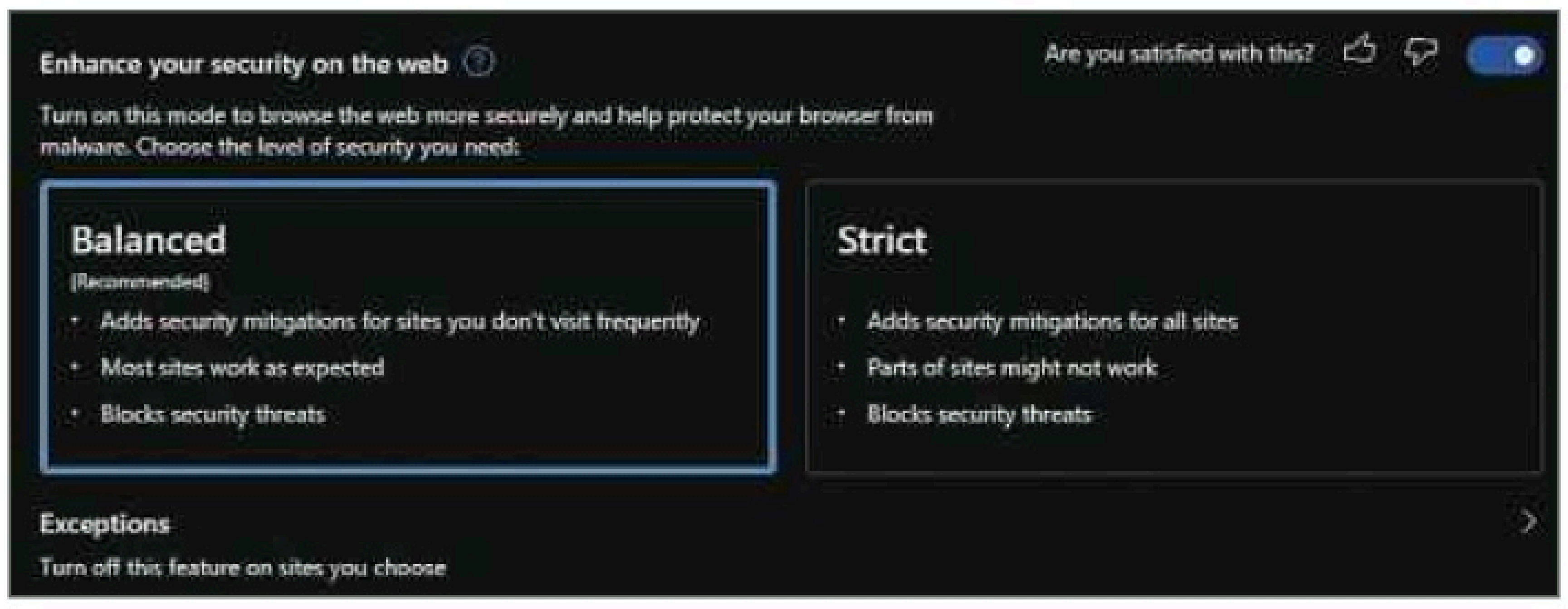
There was also a spate of pop-ups reported by users last year who, when attempting to download Chrome via Edge, were informed they would have "added trust" using Edge and offering just one "browse securely now" option to dismiss. Truth be told, and when you look beyond system resource-hogging issues, the main browser differentiator these days is more privacy than security related. Hence why I use DuckDuckGo as my iPhone default, with Safari second. At some point in the coming months, we should see DDG release a privacy-focused desktop browser for both macOS and Windows, which will certainly be worth investigating. In the meantime, both Edge and Firefox have made some changes that impact upon security and are worth mentioning, even if one of them has a silly name.

The first is the Super-Duper Secure Mode (I did warn you) that can be found in Edge. I'll refer to it as

SDSM for now, although you won’t find that option in your Edge browser settings. What you will find if you navigate your way through Help and feedback | About Microsoft Edge | Privacy, search, and services | Security, is something labelled as “Enhance your security on the web”. This is described as a mode to browse the web more securely and protect you from malware, and it needs to be enabled to get the benefits of SDSM. Those benefits include the disabling of the just-in-time (JIT) component of the V8 JavaScript engine found in Chromium-powered browsers. There’s a rather long and technical explanation of this to be found in a Microsoft Browser Vulnerability Research posting at **pcpro.link/330superduper**, but here follows the much condensed “gist of it” version.

Essentially, JIT compilation boosts web performance by converting JavaScript into machine code, using a process of speculative optimisation, before execution. Remember the Spectre chip vulnerability a few years back? That was an issue with speculative execution, of yet-to-be processed instructions, and so it comes as little surprise that JIT speculation can also be a security risk. It isn’t inherently insecure, if you’ll forgive the triple negative, but as that MBVR posting points out: “Looking at CVE (common vulnerabilities and exposures) data after 2019 shows that roughly 45% of CVEs issued for V8 were related to the JIT engine.” Around half of Chrome exploits found in the wild, according to a Mozilla analysis linked to by the MBVR team, abused JIT.

SDSM disables JIT, either for those sites you don’t visit regularly (in balanced mode) or all sites (in strict mode) depending upon your risk appetite. Edge does this automatically in balanced mode, noting the sites you visit most and disabling JIT for those you don’t. Why the difference? The clue is in what JIT does, and the answer in a word is performance. You could experience page-loading times drop, but to be honest not by enough to make me wonder what’s happening or question my ISP speed. My recommendation would be to opt for the strict setting, and if you experience slowdowns of such a degree that it’s annoying, add the sites you use a lot to the exceptions list and they will still feature JIT. I base this advice on the fact that reducing the attack surface is always a good option, especially when the flipside of the mitigation can mostly be measured in a second or two of additional page-loading time. At the very least, give it a go if you’re an Edge user, as it’s not going to break stuff and you can always turn if off if it does.



Enhance your security on the web

Turn on this mode to browse the web more securely and help protect your browser from malware. Choose the level of security you need:

Balanced
(Recommended)
- Adds security mitigations for sites you don’t visit frequently
- Most sites work as expected
- Blocks security threats

Strict
- Adds security mitigations for all sites
- Parts of sites might not work
- Blocks security threats

Exceptions
Turn off this feature on sites you choose

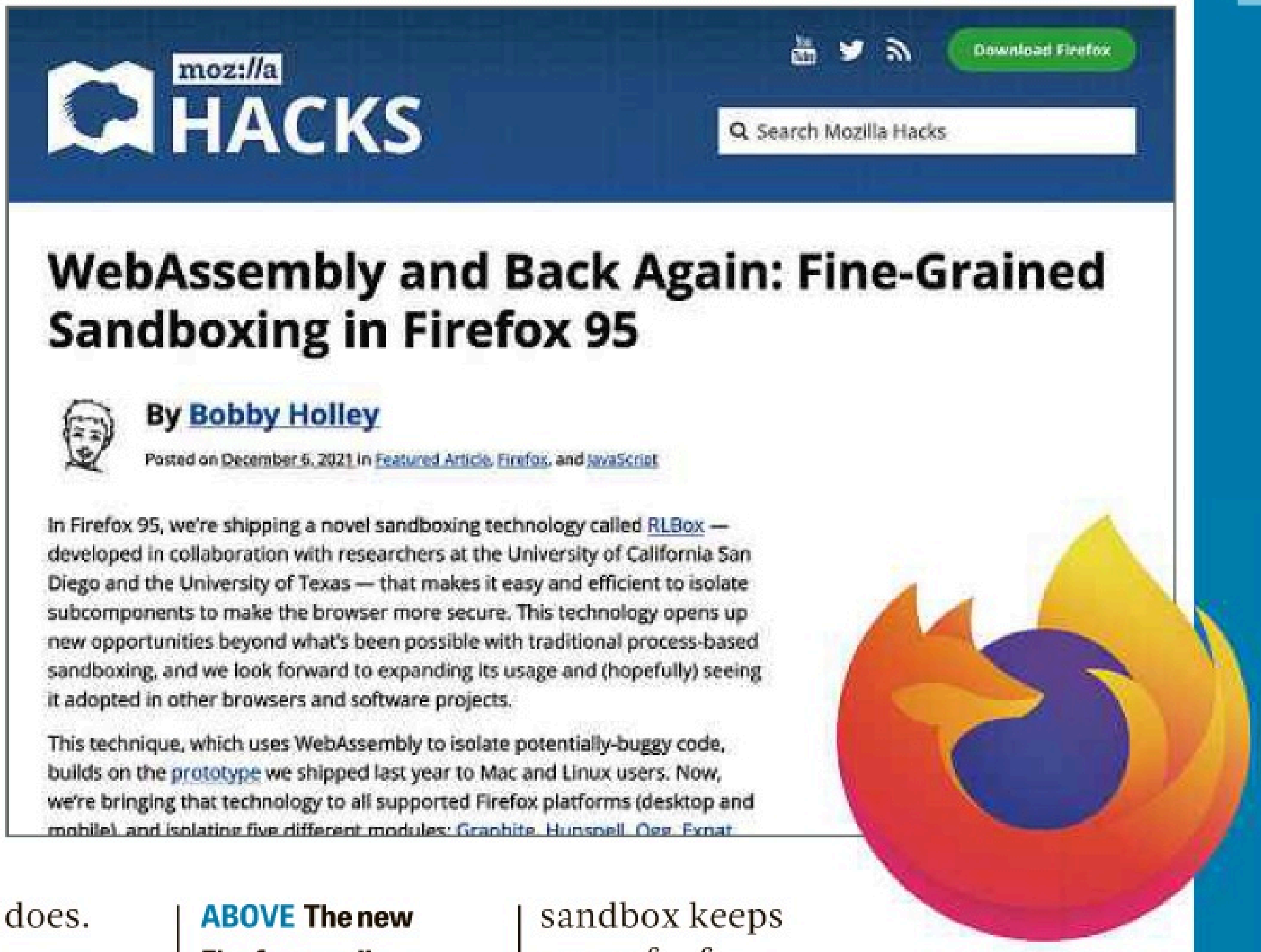
RIGHT Edge’s Balanced mode disables JIT for sites you don’t visit regularly

Building castles in the Firefox sandbox

While Microsoft’s Edge has overtaken Mozilla’s Firefox in the “which browser comes second to Chrome” usage stats, Firefox is also addressing security with a recent interesting update. That interest becomes sharper when you realise this particular feature update focus is zero-day protection. Firefox version 95 introduced something called RLBox, a new and rather cleverly “fine-grained” sandboxing system.

Sure, sandboxes are nothing new. Windows has a completely isolated virtual desktop environment (Windows Sandbox) where you can run untrusted code securely without impacting the host machine, and from where you can also run Edge in splendid isolation. I suspect I know what many of you are thinking: “Acksherly, all browsers, including Chrome, use sandboxed processes for sites and applications so as to protect from malicious code anyway.” Which is true, but not all maliciousness can be contained quite that easily.

This is where Mozilla comes in, with help from boffins at the universities of California San Diego and Texas, having developed the RLBox technology here. Think of it as an extension to the sandbox idea, one providing added protection for chained vulnerabilities that are used to escape standard sandboxing methodologies. The new Firefox sandbox keeps you safer from vulnerabilities in third-party libraries; it’s a runtime library sandbox, hence the name.



WebAssembly and Back Again: Fine-Grained Sandboxing in Firefox 95

By Bobby Holley

Posted on December 6, 2021 in Featured Article, Firefox, and JavaScript

In Firefox 95, we’re shipping a novel sandboxing technology called RLBox — developed in collaboration with researchers at the University of California San Diego and the University of Texas — that makes it easy and efficient to isolate subcomponents to make the browser more secure. This technology opens up new opportunities beyond what’s been possible with traditional process-based sandboxing, and we look forward to expanding its usage and (hopefully) seeing it adopted in other browsers and software projects.

This technique, which uses WebAssembly to isolate potentially-buggy code, builds on the prototype we shipped last year to Mac and Linux users. Now, we’re bringing that technology to all supported Firefox platforms (desktop and mobile), and isolating five different modules: Graphite, Hunspell, Ogg, Expat

ABOVE The new Firefox sandbox keeps you safer from vulnerabilities

It’s important here to note I’ve carefully used terms such as “added protection” and “safer” rather than “safe”. RLBox isn’t a silver bullet that will kill all attempts to compromise Firefox, but it does complement things such as site isolation (also added in Firefox 95) and make your browsing more secure. It does this by isolating a set of third-party libraries. At the time of writing it covers the following against zero-day vulnerabilities: Graphite (font rendering), Hunspell (spellchecker) and Ogg (multimedia container).

“Because of the modular way RLBox works, it could appear in other browsers at some point”

Because of the modular way RLBox works, compiling code first into the portable WebAssembly format and then native code, it could well appear in other browsers at some point. Further components may also be added, and I understand that Expat (XML parser) and Woff2 (web font compression) will be supported in, hopefully, Firefox 96. However, Mozilla engineer Bobby Holley has been clear (see **pcpro.link/330sandbox**) that not all components are suitable as they are more dependent on shared memory or the “modest overhead” of using RLBox would impact their performance too much.

Your appointment with malware has been cancelled

I’ve been banging on about a security problem with Google Calendar, an app that’s been downloaded more than a billion times, for several years now. Way back in the summer of 2019 (although security researchers first brought the threat to attention in 2017) I was warning that unsolicited Google Calendar notifications could be used for malicious purposes. Bad actors could create a calendar event

Continued from previous page

and add your email address as a guest, then that event would show in your calendar. These have primarily been used to effectively spam unwary users with links to phishing and credential theft sites.

I used to call this a "non-traditional attack vector", but it's become so widespread that I can't in good faith use that term any more. Up until recently, the only mitigation I could offer was twofold: to turn off the "automatically add invitations" option in the Google Calendar event settings; and to remove the automatic adding of events function from Gmail (by configuring the "Events from Gmail" option so that the "Add automatically" box is also unchecked). The problem is that this kind of scheduling is key to many users' workflows.

When I have previously asked Google for comments on the issue, it has always maintained that its terms of service prohibit the spreading of malicious content. The underlying message has been that functionality would be impaired for legitimate API events, and that this was a spam issue rather than a security vulnerability. By the time you read this, Google will have rolled out changes to make it easier to block these invitations.

The latest Google Calendar event settings options have been amended to "prevent unwanted invitations from being add to your calendar" according to a Google Workspace team update statement. These now add "Only have them automatically added if you have RSVP'd in the email event invitation" as well as the "Always" configuration setting. By choosing this setting, you will then get an invitation email for all events, even if the organiser hasn't opted to send one. The idea is that this bridges the usability (help prevent missing event invitations) and security (help prevent malicious event notifications) gap in the most efficient way.

It's taken way longer than it should have done, but I'm glad that Google has finally responded to the concerns of many in the security arena. I'd have preferred it to have been on by default, rather than off, but you can't have everything.

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STEVE CASSIDY

"It's very important to take a long, hard, cynical look at your server estate"

Steve attempts to quash the rocketing running costs of his server room with some rationalisation, before taking to the skies with Azure Space

Steve is a consultant who specialises in networks, cloud, HR and upsetting the corporate apple cart

@stardotpro

I'm sure I am not the only person who, to some extent, hides away behind the technology when bad news comes to visit. The only problem this time is that the technology is part of the problem. The 50% hikes in energy prices look to be only temporary, but they are nonetheless painful intrusions into life both at work and at home. Looking around my own bijou machine room, I thought I had done a pretty decent job of minimising energy spending. All I had to really think about was why, if I closed the inner door (the outer being an up-and-over garage door, with lots of air movement through metal slats), the room would be at a comfortable, not to say oppressive, 28°C by the following morning.

I thought I'd been paying attention to energy consumption, which in old network nerd terms means that my servers with the extra-large 15A mains plug aren't left connected for very long, but there can be no denying the secondary ability of the room as a wet cycling gear drying rack. I tried to forget the issue but it came back to haunt me at my most vulnerable, bored witless over Christmas: I couldn't get away from the fact that in my network Browse List, I could see 11 hosts. This is almost exactly the inverse of Microsoft's old-world statistic for the average number of users per server. I'm such an uber-nerd, I have multiple servers per user.

Not all those machines are created equal. In particular, I've made heavy use of small, older NAS boxes, made initially by Iomega, then sold to Hitachi and then again to Lenovo. Given the choice between a massive server drawing something like 400W with a population of enterprise-grade disks or a NAS device drawing 35W, I thought I was getting best bang per watt by spreading my storage across the fabric of my network. It turns out that this does give me good resilience and decent performance – but these pros were rapidly being outweighed by the power-hungry con.

My big problem was that a 35W NAS box can easily draw 90W, especially if it has a full complement of disk drives – and I have three such boxes, fully populated with 2TB SATA drives. These have been marvellously durable, touch wood – but also noticeably warm. Warmth in electronics equals money on electricity to run them.

Hence the campaign to get some big, modern drives into service and

BELOW My real server room (below left) wasn't running as cool as my dream server room (below right)

ABOVE **Azure Space lets you connect with your company's suite of orbital satellites**

then do a bit of consolidation of my data. This actually all kicked off before the main pandemic lockdown, which is just as well, because some directory comparisons and file-copy utilities take days, or even weeks, trawling through 6TB RAID arrays accessed over a grab-bag of patch leads and switches. I haven't chased down every last scrap of the maths, but it seems quite likely that with four larger drives – two 12TB, two 18TB – I can just about keep two complete copies of the stuff I need to have available, which will free up 21 spinning drives, spread between LAN accessed NAS iSCSI services, and direct physical disks in servers.

Twenty-one drives is a lot of spinning hardware. Individually they feel hot: if you've ever hot-swapped one in a running server you'll know that unique sensation of something valuable, still spinning, and a bit over finger-tolerable temperature sitting heavily on your palm. I haven't seen any ready-reckoner formula for the drive temperature that tells you how many watts it takes to keep something that hot, per hour, but with energy prices what they are at the moment, it can't be long before one is made available.

I have been monitoring for any signs that I'm going to get a false economy – that the big drives run super fast or super hot and draw more than their predecessors, but so far I've not found any evidence of that happening anywhere.

It's also important to take a long, hard, cynical look at your server estate, with a view to isolating the older, high-consumption products. In my case, the main culprit is obvious: my first-generation Mac Pro is using eight very old cores to run some even older software, in the shape of Mac OS X Server. To be sure, this is wonderful bulletproof stuff, and Apple has not made an upgrade easy. I may be taking my own advice soon, trying to move the server install to a Mac Mini Server.

Gates in space

I don't get many guffaws out of the IT business. There are a few that stand out – Vodafone's "MooCall" story is one such – but I had a definite twitch from the chuckle-muscle over an announcement from Azure. It now has a suite of services it collects under a single banner: Azure Space (**news.microsoft.com/azurespace**).

This is a suite of plug-ins and services that lets you connect with, download from and possibly even control your company's suite of earth-orbital satellites. Seriously. Microsoft seems to have built or bought a world-covering network of uplink relay stations, so you don't even have to figure out how to talk to your particular target satellite.

Azure's global infrastructure has made this as simple as the pit-lane networks I saw in Formula 1. It's neat that one IP on a race circuit network can be a racing car, but it's a whole lot more amazing when one IP can be a satellite 30,000 kilometres away. And that IP can be migrated to the next uplink station as the Earth turns, without you needing to be bothered by where it is or whose connections you pass through to talk to it. That's seriously cool.

Microsoft itself talks about doing some slightly odd things with your satellite link. "Looking through clouds" is an aspirational statement that actually has nothing to do with the infrastructure connections: it's about image enhancement, which to be honest you can do by bringing your satellite picture data to the imaging specialist on a 9-track tape reel. There's nothing about the job of image enhancement that makes the Azure contribution to the process any more important. I wandered through a lot of excited paragraphs that mostly seemed to be about Azure supporting the formats used by existing satellites, for the more exotic types of photography they specialise in. This is database munging scut-work, the kind of thing for which I used to write programs in Turbo Basic or Modula-3 to solve weird layouts or obscure character coding.

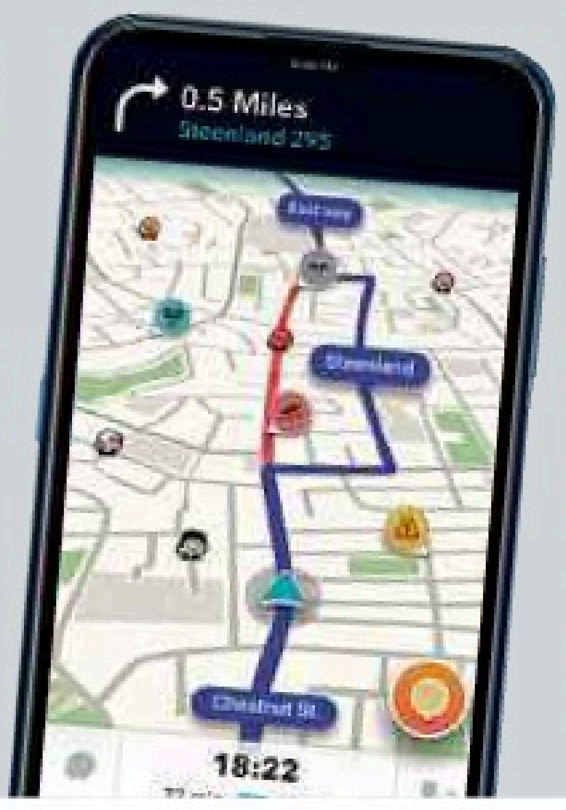
The parts of the site and the info pack that tell you about using Azure to actually emit control orders to a satellite are, I guess, necessarily vague. If that's your business, then you can evaluate whether they understand your needs, but to an outsider, the promises seem a little scary. Fire the deorbital motors! Spin down the lightsail! Not things I was thinking about as drag 'n' drop icons on an IoT device access builder like Azure's. I expect we have some satellite management types in the *PC Pro* reader pool: I'd very much like to hear your opinions on the Azure Space feature set.

> **"Microsoft seems to have built or bought a world-covering network of relay stations"**

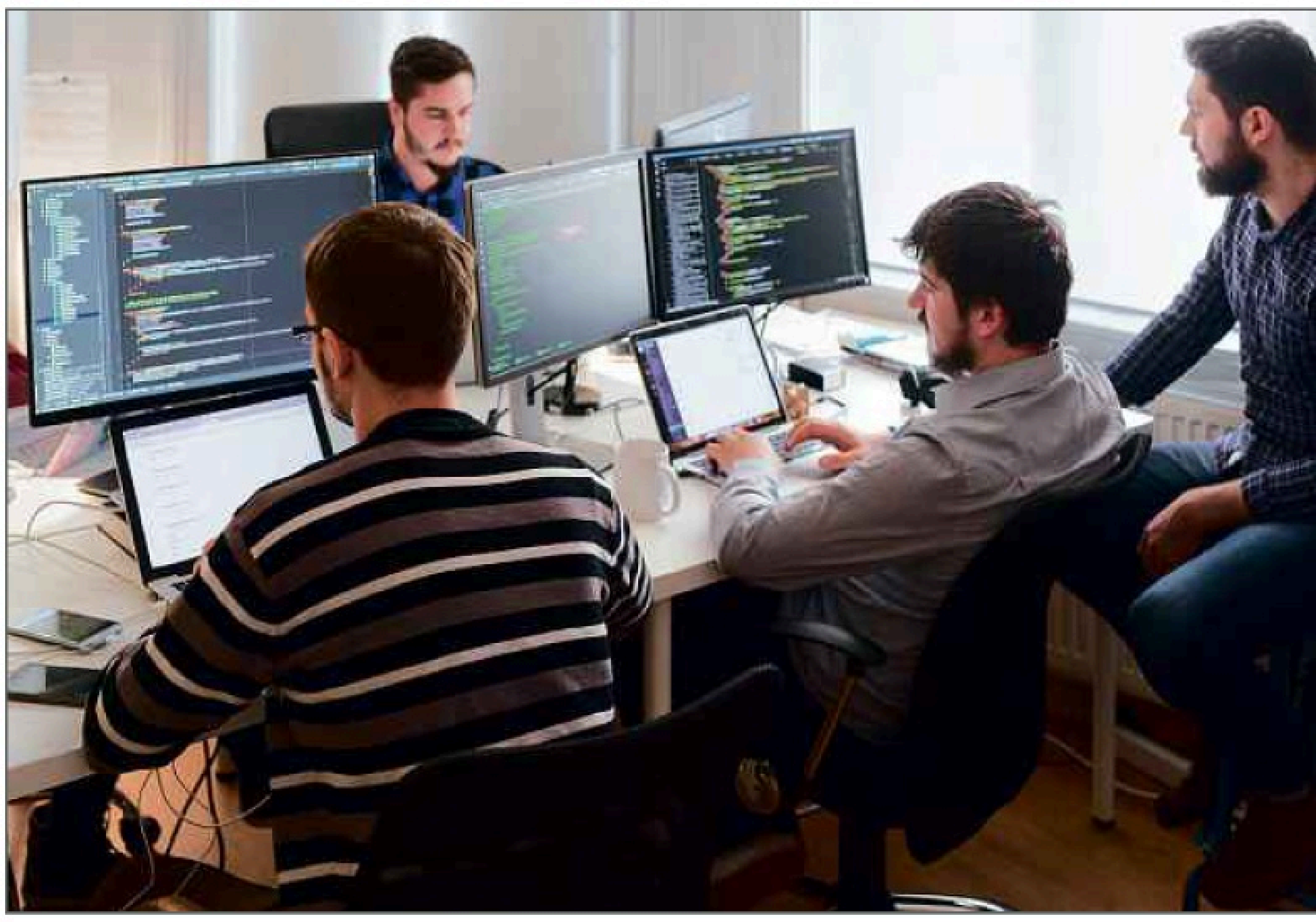
It's not just servers, either

Back in the good old 20-teens, my go-to device for car satnav was my Microsoft/Nokia Lumia 950XL. No matter how you feel about Windows for Mobile phones, the 950 is an interesting machine, and the free lifetime updates to worldwide maps are hard to ignore. The only problem in everyday use was that after a couple of hours of map display, GPS and route-planning duty, the device would be too hot to hold. Hanging it in front of the dash vents was the only fix.

If, that is, you intend to carry on using what you were pre-pandemic. Quite by accident, I left the house for a trip to Europe with the wrong phone. Setting up Waze on the Nokia X20 was simple, and the ferry Wi-Fi didn't actually melt down while I was getting the local map cache and my preferences all just so. And the heat problem, so obvious on the 950XL, was but a faint memory. There's probably half a decade of development between the two devices. While that progress wasn't obvious enough for me to spot from the outside, the performance differences are totally persuasive.



LEFT **The Nokia X20: not too hot to handle**



ABOVE Around 40% of IT workers want to change not just jobs, but careers

The Great Resigning

The minute I walked through my client's doors I could tell something had changed. Not just for the reasons we're all familiar with in 2022: this was a set of fresh faces, not at all concerned by the risks of being in the office together. Eventually, I found my usual contact and we hid in the gossip farm – sorry, I mean the IT room. What on earth had happened? In essence, he said, about 20 of the workforce had simply not returned to their desks when the restrictions were lifted. They all wanted to change jobs and had resigned. This produces my headline here, and I should apologise to all my nerdy readers by explaining that the Great Resigning doesn't refer to signatures on website server certificates. It's not re-signing anything: it's quitting, as in jobs.

It turns out this is all about "secret sauce". I remember a meeting in Cambridge to celebrate a breakthrough in genetics research and supercomputing. The presenters were the researchers, not the techies: at the appropriate moment, the professor gestured magnanimously to a trio of T-shirted chaps and paid tribute to their contribution, keeping the machines running and tweaking the sequencing software to bring it closer to the job at hand. Not forgetting, he added, that "secret sauce" all you strange IT people keep adding to projects, just when required.

A small chuckle faded rapidly away in the audience. Most tech journalists have some time in their CVs spent in IT jobs, and the uncomfortable relationship between bosses who don't do detail and IT workers who absolutely live it day and night was laid rather more bare in that moment than most of them preferred.

I doubt many journos or IT sector workers would have foreseen the state of the labour market in the UK in 2022, as the figures are pretty incredible. Something like 40% of the workforce want to change not just jobs, but entire careers. That's not 40% who are unwilling victims of post-Brexit market conditions or constraints imposed by Covid: it's 40% who have been staring at the wallpaper for 18 months and decided they want a change of lifestyle.

For enterprise data systems, this is a literally unprecedented situation. We are used to the idea that experience is king, that the pool of suitable candidates is small and that the salary packages are easily justified and compared. None of those assumptions stands any more. The idea that a disgruntled CIO or cloud service manager can hold a business to ransom just doesn't work when 20 other guys have had a year and a half to learn at least the book-presented side of the job, if not necessarily how you choose to implement your databases, packages, resources and processes.

It's also a matter of understanding what's been happening with your suppliers. From what I can see in the wider IT marketplace, those 18 months of on/off lockdown have been an ideal incubator for the kind of version-update, platform change, re-architecting work coders always wanted to do in the olden days, but could never sequester the enormous stretches of quiet time needed to turn thoughts into lines of code. That being the case, with new versions of almost everything popping up all around, the argument that you have to keep the old support team chained to their desks because of their experience doesn't hold water. Hire a new guy to build a new platform, because the platform's coming no matter what, and everybody is on day zero with that irrespective of their length of employment.

Thinking outside the box is also recommended. While the corporate software space is full of partners and developers, busy with the two main planks of systems integration or outright customisation to produce a live connected workflow architecture just for you, it's also true that a lot of people who are used to thinking of themselves as outside the technical career path are perfectly capable of handling 90% of the daily life issues raised by a local server farm or distant cloud constellation.

> "Do you need the hardcore IT gurus with their secret sauce approach?"

You have to evaluate the team you're left with. Do you need the hardcore IT gurus with their secret-sauce approach, or is your software suite refreshingly free of bottlenecks, weirdness, bloat or any of the other purely IT-side errors? Could, in fact, your most enthusiastic non-IT users be in a position to run the whole show?

It's strange to see how company culture redivides ideas. At one and the same time, the assumptions were that cloud computing might let you go serverless, and shortly thereafter, nerdless – yet those same people given to talking about secret sauces are the ones who dare not rock the boat when it comes to salary reviews and staff appraisals in the IT team. I doubt that Microsoft's Azure Space project is especially reliant on black-box code within web plug-ins someone downloaded from an anonymous dev's page on GitHub: the more expensive the assets being messed around, the less tolerable it is for so-called secret sauce to be an indispensable component of the entire system, from your laptop up to the shiny, panel-bestudded box in orbit.

For those of us with more straightforward, easily managed needs, the time spent by services coders during WFH is actually more impactful than the wayward career fantasies of the IT guys. The moment a simpler version of some nasty old website emerges, the skills required to drive it leave the IT section and move to any worker; I haven't yet seen any sites become harder to use after a root-and-branch update. Easier site design means less IT intervention, and that means less demand for IT workers: something of a sting in the tail for those who think the Great Resigning is their chance to make it big.

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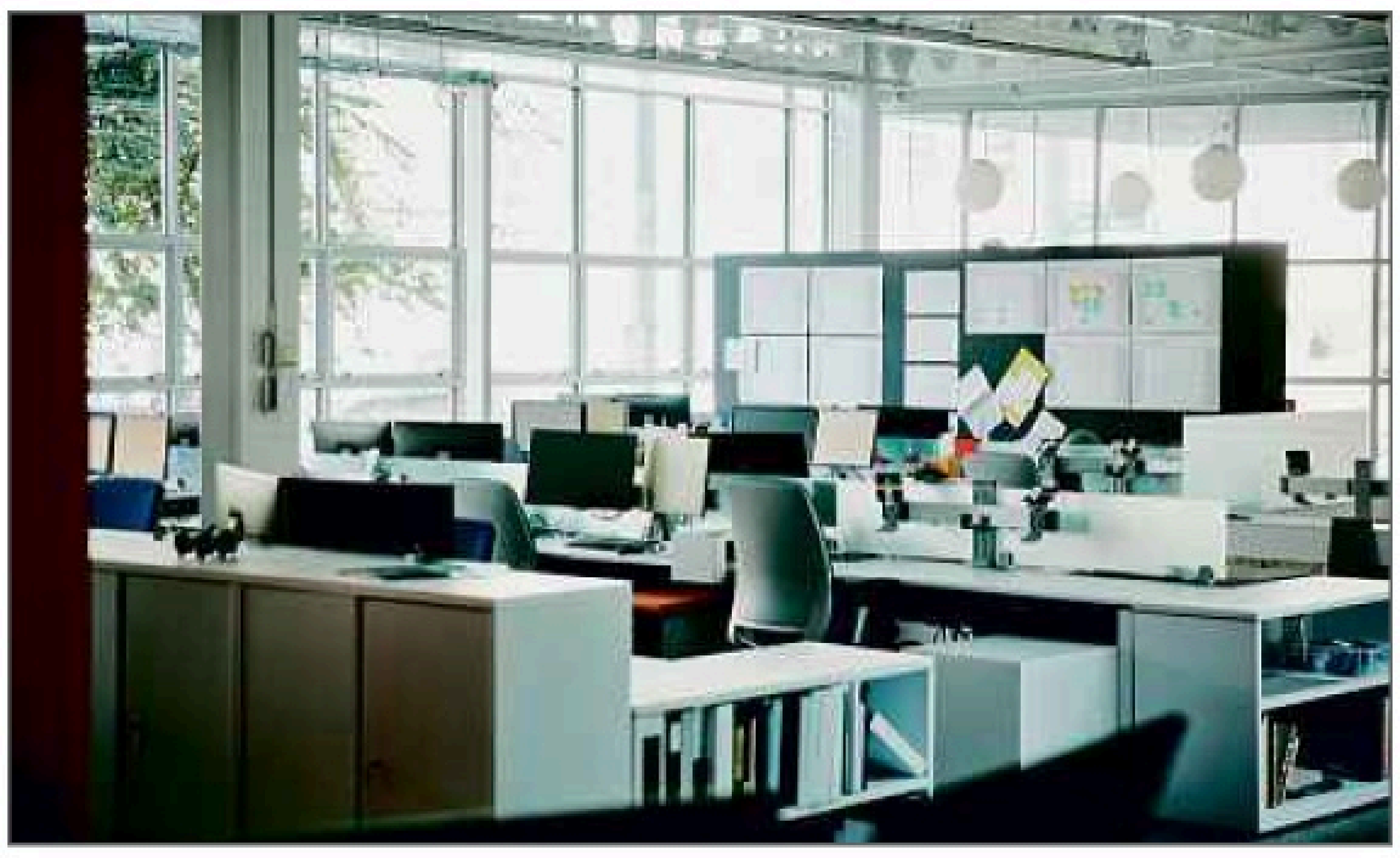


BELOW Empty offices during lockdowns have changed the whole IT dynamic

RETRO

Inspirational stories from computing's long-distant past

Why retro enjoys a taste of Raspberry Pi

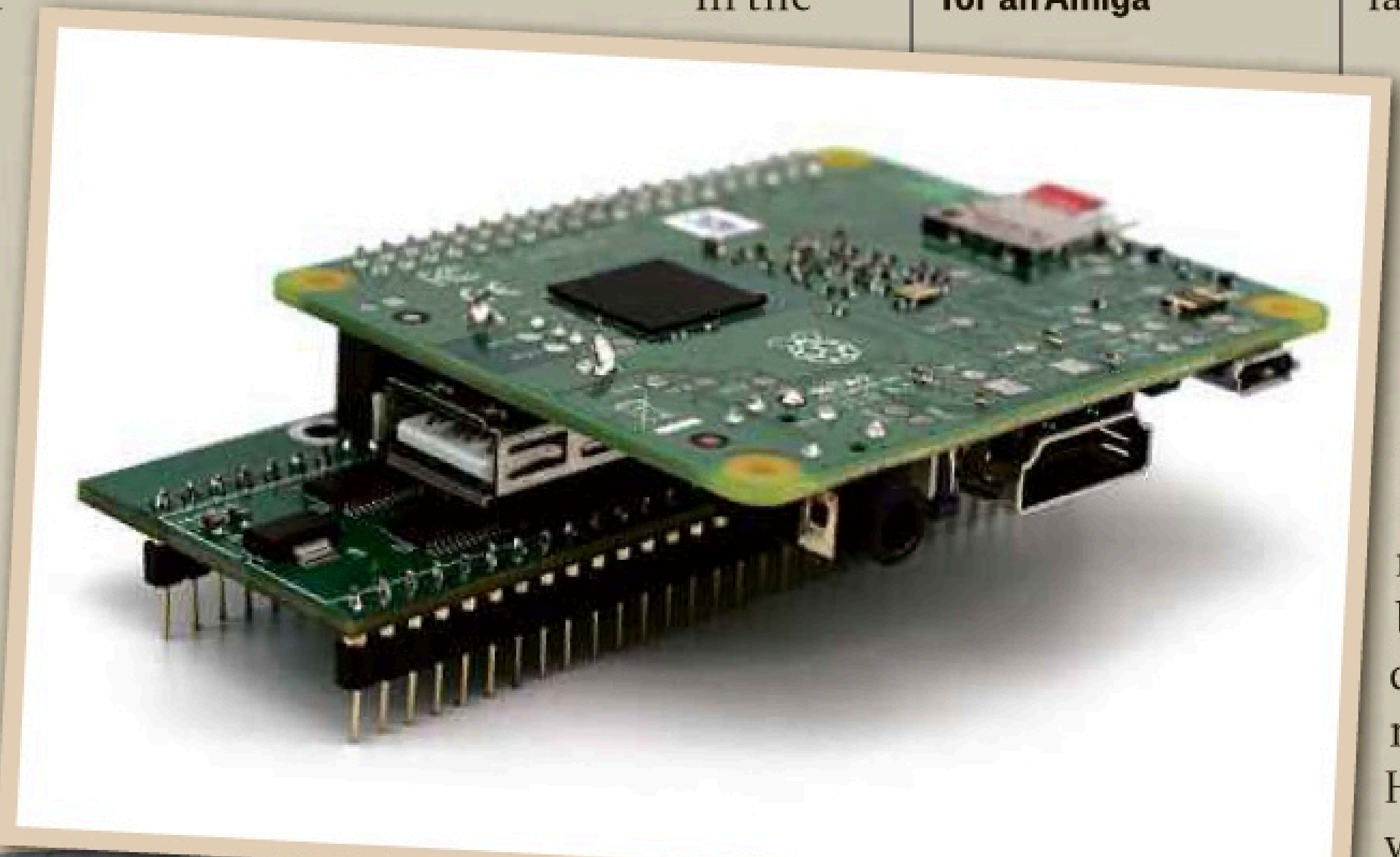
Ten years after the launch of the Raspberry Pi, David Crookes looks at how it has given retro computers and consoles a new lease of life

On 29 February 2012, a tiny British-designed computer costing just £22 went on general sale, promising to help children learn how to code. Within minutes, the first batch of Raspberry Pi devices had sold out and the brains behind it realised they had a major hit on their hands.

Even so, few would have predicted how big a success it would be. Having sold 100,000 units on the first day, it surpassed 8 million sales just four years later. At that point it had beaten the Amstrad PCW as the best-selling British computer. Today, more than 40 million boards have been sold.

Far from being a flash in the pan, the Raspberry Pi is on to its fourth main model. There are two smaller versions – Zero and Pico – and a unit called the Raspberry Pi 400 that harks back to the days when computers were placed in the same case as the keyboard.

In some respects, that has brought the Pi full circle. A lot of the incentive for creating the low-cost machine lay in the legendary BBC Micro, the computer responsible for introducing an entire generation of British schoolchildren to the delights of BASIC programming.



BELOW **The PiStorm adapter acts as a low-cost accelerator for an Amiga**

But the Raspberry Pi has also helped revitalise some of those old machines. Although most retro enthusiasts concentrate on getting the most out of the original computers, some are hell bent on taking things further.

The Raspberry Pi has enabled people to emulate old machines but also expand on their capabilities, and saved a lot of old tech from ending up in landfill. "I'd never consider throwing away a retro computer, but before the Raspberry Pi option came about, I can see how people would think about doing just that," said tech enthusiast Stephen Williams.

A year or so ago, Williams bought a broken Commodore 64 that couldn't be fixed using spare parts. Instead, he decided to tear the machine apart. His actions weren't born from frustration or a desire for destruction, but to bring the machine back to life using a Pi board. He isn't alone in such an endeavour, with the affordable computer long having become intrinsically linked with the flourishing retro scene.

"The Raspberry Pi has enabled people to emulate old machines and saved a lot of old tech from ending up in landfill"

In Williams' case, the Commodore 64's motherboard was replaced by a Raspberry Pi computer, with Lego used to keep the device, wires and ports in the right place. He then connected an Arduino Micro to the Pi, which allowed the original C64 keyboard to be used.

LEFT **It may not be retro, but Raspberry Pi can put a fresh spin on any computer**

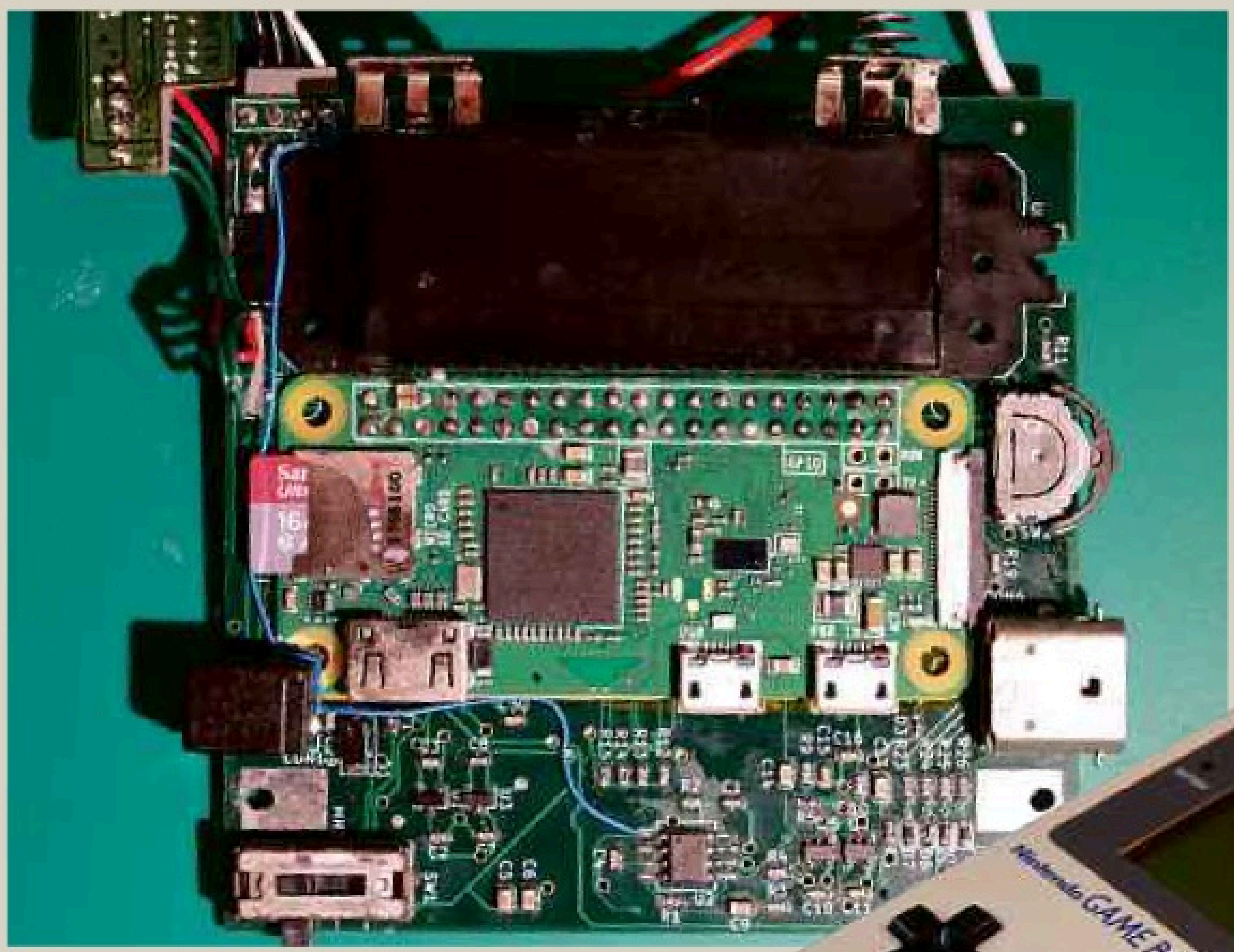
"I've repaired or future-proofed a lot of old computers, but it's great to know that, if a board is really done for, you could feasibly rig up a Raspberry Pi inside the casing," he told *PC Pro*. "It keeps the nostalgic look and feel of the original machine but it also lets you do modern things such as run a decent media player or play YouTube videos. It was inevitable Raspberry Pi would move into the retro space."

Using emulators

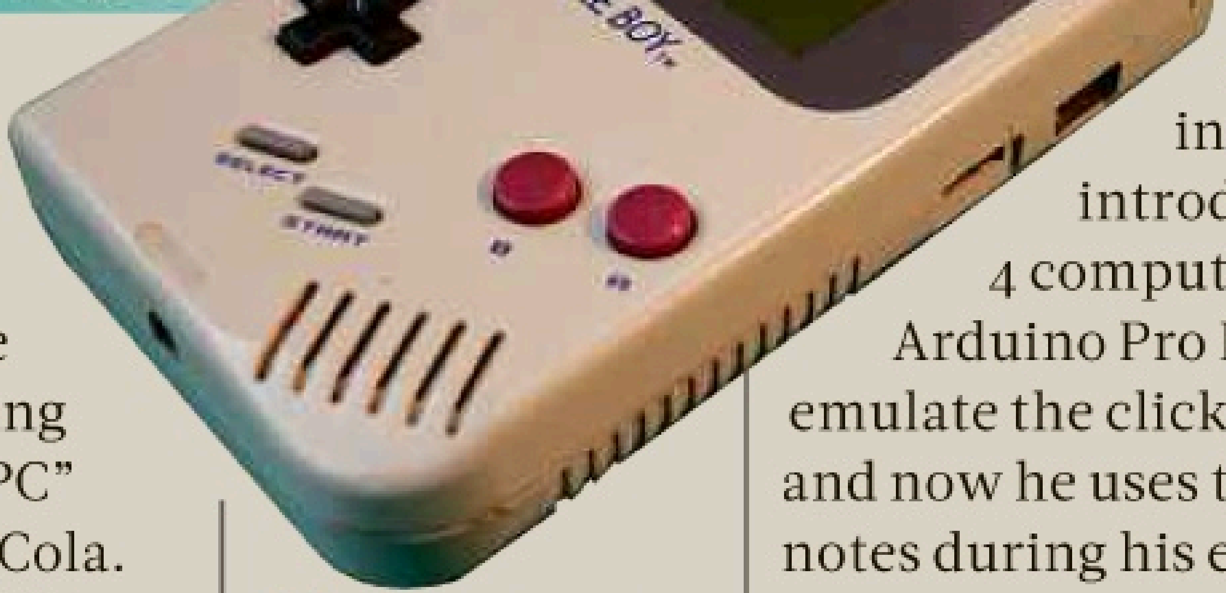
Pivotal to this movement was the development of emulators such as PiMAME (now PiPlay), one of the first to be released for Raspberry Pi in 2013. Since then, lots of software packages have emerged, including RetroPie, Lakka and RetroArch. By allowing the tiny machine to behave like other computer systems, enthusiasts have been able to mimic almost any classic machine, from the ZX Spectrum and Commodore 64 to consoles such as the SNES and Mega Drive.

Williams used RetroPie for his Commodore 64 build, which ensured it looked and behaved just like the original. "The emulators are fantastic," he said. "The loading times are quick and they are so convenient." Using Raspberry Pi also means modern monitors and game controllers can be plugged into the HDMI and USB ports. "You can even have network access," he added.

The prevalence of emulators means Raspberry Pi forms the basis of many homemade retro video-game consoles – one of the easiest and most popular projects, since it only really involves installing a bunch of emulators, getting hold of gaming ROMs and connecting a gamepad.



TOP This Pi Zero has been fitted inside a Game Boy console



ABOVE Original and custom carts can be used in this Game Boy

Some people have also created large Pi-powered arcade cabinets, while others, such as Michael Pick, have gone the other way, in his case devising the "World's Smallest Gaming PC" that's tinier than a can of Coca-Cola. He followed that with the "World's Smallest iMac" using a Raspberry Pi 4 inside a 3D-printed case containing a 7in screen, while an image called iRaspbian provided the look of macOS. The possibilities, it seems, are only limited to people's imagination.

"One of the best things about using Raspberry Pi is that it's open source and there's a lot of information available online," said retro maker Gautier Serodon. "Many communities have set up around Raspberry Pi as well so it's easy to ask questions and find any answer. It's very cool."

Serodon tapped into such knowledge when he was giving a Minitel terminal a makeover. Unlike Williams, who aimed to evoke memories of the Commodore 64 by making his version almost indistinguishable from the original in both how it looked and operated, Serodon wanted to combine the old with the new. "I wanted to turn an old, unnecessary item into something useful," he said.

Minitel was a French online network that launched in 1982. Effectively France's precursor to the World Wide Web, it offered banking, email, train booking, phone directory and adult chatroom services, but the plug was pulled in 2012, rendering the terminals useless.

Having bought a Minitel 1B, a terminal made in 1982 by Telic Alcatel, Serodon got to work. He stripped the terminal of its insides, inserted a 10.4in LCD panel into the case and introduced a Raspberry Pi 4 computer. He also used an Arduino Pro Micro to retrofit and emulate the clicky AZERTY keyboard, and now he uses the device to take notes during his engineering classes.

Levelling up

Such an approach is common, but using Raspberry Pi boards to breathe new life into an existing computer is only part of the story. An even bigger achievement is to mod a retro machine that can remain compatible with original peripherals.

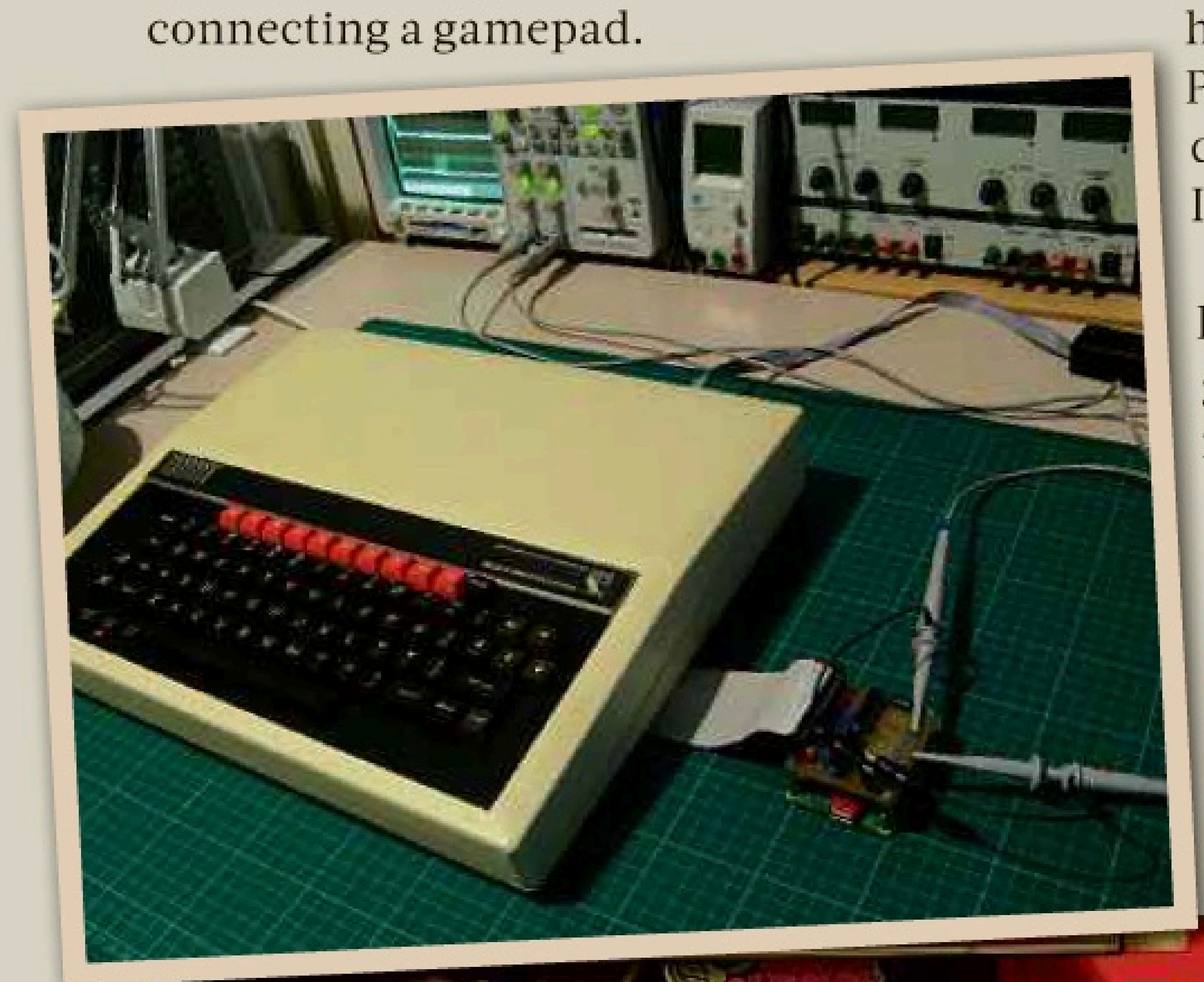
Jeroen Domburg, for instance, created a working Nintendo Game Boy using a Raspberry Pi Zero W and a custom four-layer PCB in place of the handheld console's motherboard. Yet it was capable of running games from original Game Boy cartridges. It could also play non-Game Boy titles via Pi-based emulators run from custom-made carts.

What made this build even more impressive was that you would never know this was a mod by looking at the device. The Game Boy appeared as if it hadn't even been touched, not least because the project used the original LCD screen, buttons, case and link port.

It's a great example of how Raspberry Pi can enhance a retro machine. "Most of us grew up in a world where we either had or longed for particular consoles and computers and a lot of us wanted them to do more," Domburg said. "Now we're all grown up, we finally have the means to turn those youth dreams into reality, and some of us decide to indulge in that."

What Raspberry Pi does, he says, is allow people to slip on an enhanced pair of rose-tinted specs. "Nostalgia tend to work as a filter," he told *PC Pro*. "We remember how impressed we were with the graphics and sound of these machines from the 1980s and 1990s but we forget the long loading

"Many communities have set up around Raspberry Pi so it's easy to ask questions and find any answer. It's very cool"

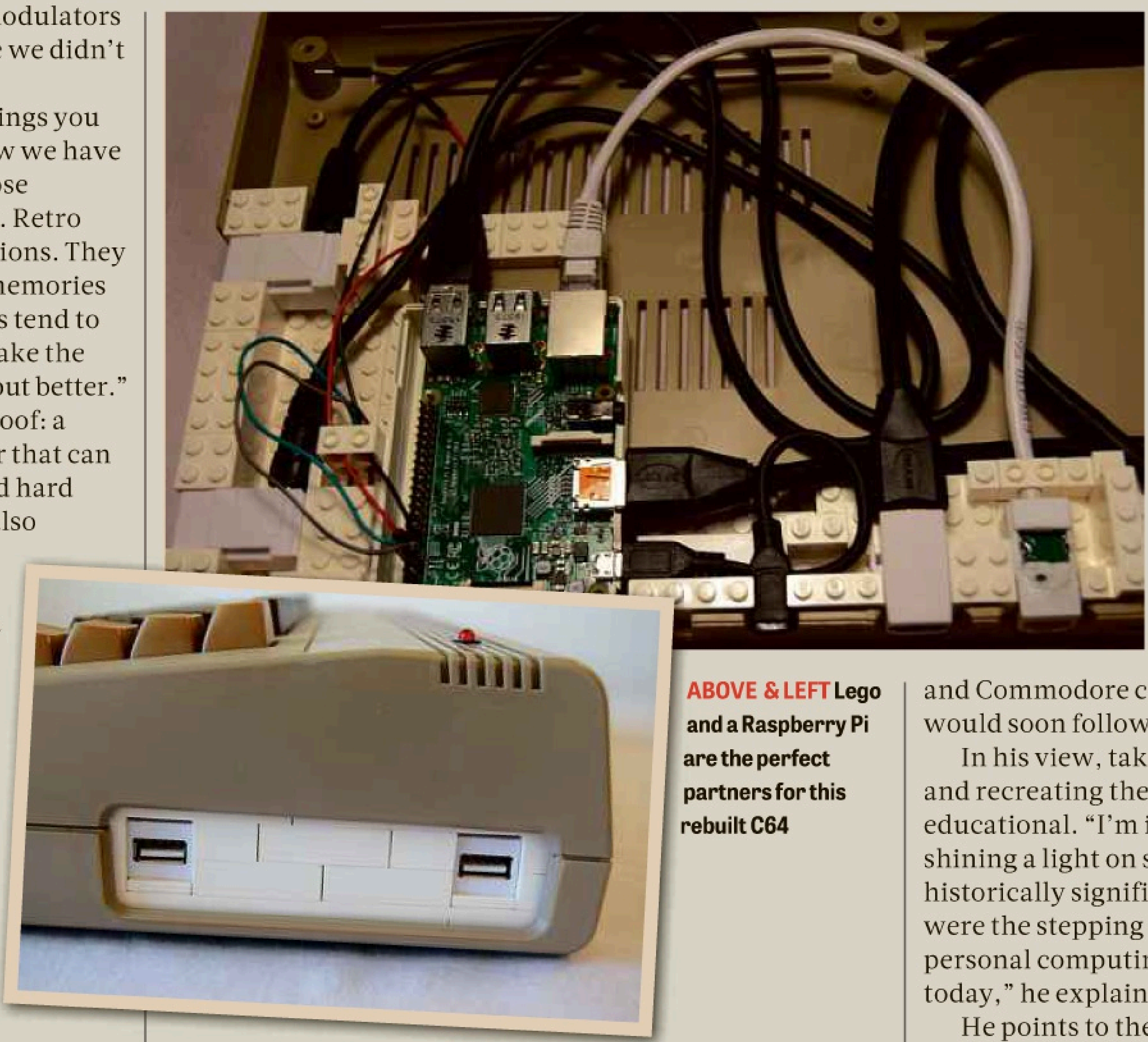


LEFT David Banks' project recreates the hard-to-find second Acorn processors

LEFT This recreated Amiga placed a Raspberry Pi 4 in a 3D-printed case times, bad disks, noisy RF modulators and so on – possibly because we didn't know better at the time.

"Back then, they were things you would just live with, but now we have much faster technology, those limitations become limiting. Retro mods get rid of those limitations. They make the hardware fit our memories more. All of the best retrofits tend to work best when they still make the machines work as intended but better."

He points to RaSCSI as proof: a virtual SCSI device emulator that can mount virtual CD-ROMs and hard drives on vintage Macs. He also namechecks PiStorm, an adapter powered by Raspberry Pi that provides a low-cost accelerator for a Commodore Amiga. All users need to do is remove the Motorola 6800 processor from an Amiga 500, 500Plus or 2000, replace it with the PiStorm add-on and connect it to a Raspberry Pi containing a Kickstart ROM on the microSD card.



ABOVE & LEFT Lego and a Raspberry Pi are the perfect partners for this rebuilt C64

Advances such as these make life easier, but that doesn't mean we should shun the clunkier aspects of past tech. Although Domburg would prefer to consign floppy disks to the past, some people still love them. Indeed, Scott Baker created a floppy disk controller for his Raspberry Pi 4. It allows him to read from and write to 5.25in floppy disks.

"Most people who are eager to re-experience some of the products they used in their youth prefer to use period-accurate equipment," he said. "But there are two issues that make that difficult. First, actual vintage equipment can be very expensive and in some cases difficult to find. Second, vintage equipment often suffers from component failure.

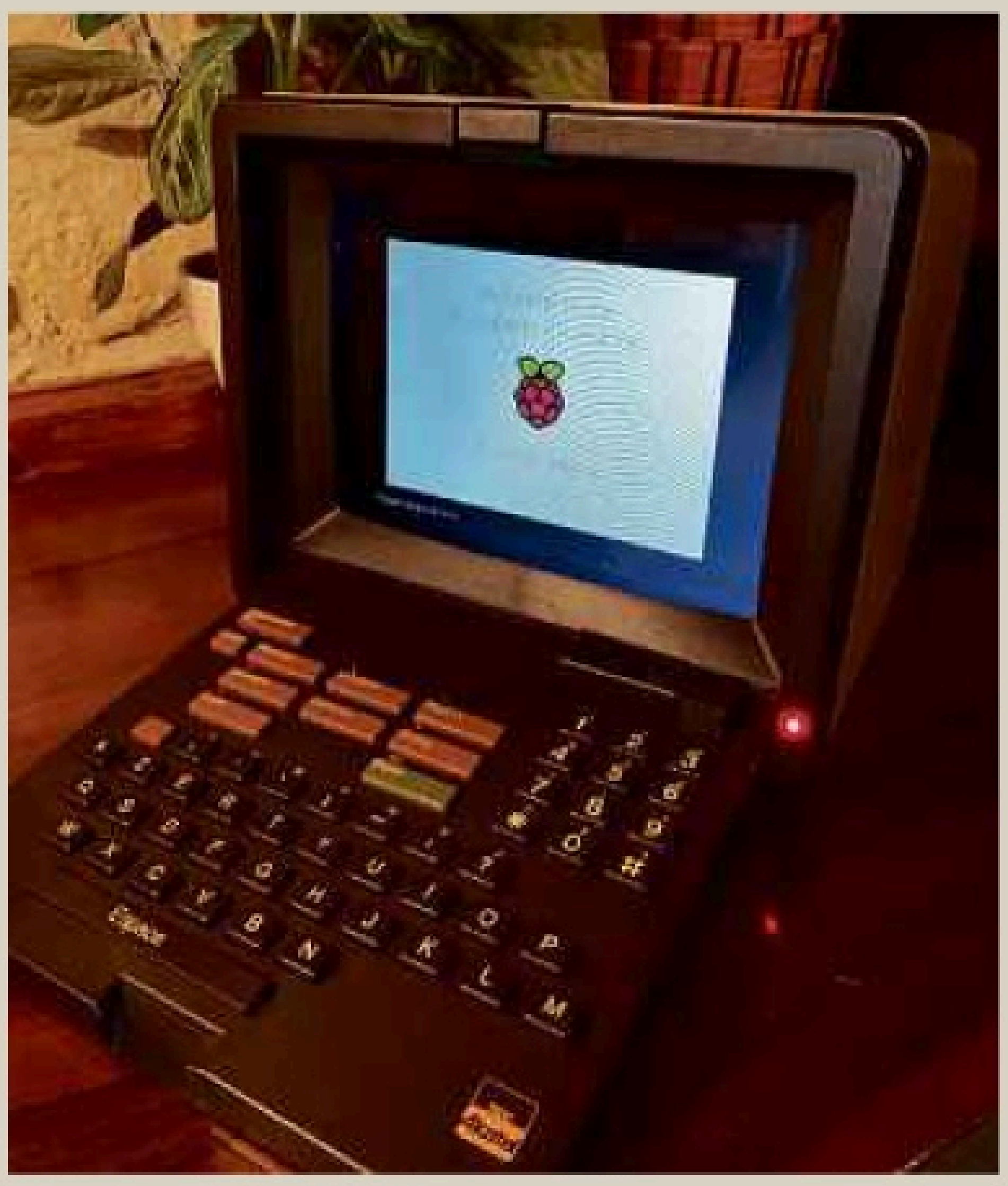
"Electrolytic capacitors, for example, are notorious for failing. Backup batteries sometimes leak and destroy circuit boards. Even ICs [integrated circuits] sometimes fail and replacement components may not always be available. Raspberry Pi is cheap and capable and it also offers other capabilities, such as built-in Ethernet. It can help to bridge the gap between new and old."

Scratching an itch

But could Raspberry Pi actually replace an entire retro machine from scratch? We suspect you already know the answer. Stephen Williams' Commodore 64 still used original components (the case and keyboard), but Billy Nesteroulis' recreated Amiga 600 was produced from all-new parts. He emulated the 16-bit Commodore computer on a Raspberry Pi 4 and fitted it inside a full-size 3D-printed replica case fitted with a specially designed Cherry MX keyboard.

By using the Ambibian 1.5 Extended Edition distro, which includes Raspbian Buster V10 OS, this build also expanded the Amiga 600's capabilities. It can make use of a modern browser, the VLC media player and Qmmp audio player as well as LibreOffice Writer. At the same time, it's powerful enough to run games and the iconic pixel-art software Deluxe Paint.

Nesteroulis' project produces an Amiga 600 that works well in the modern day, providing an alternative route to scouring eBay for used models that may still require some work to get them going. In that sense, Raspberry Pi can continue the legacy of machines that would otherwise become lost to time. If it wasn't for the Raspberry Pi, for instance, very few of us would get to tinker with a Sol-20 – an obscure machine that appeared on the cover of *Popular Electronics* magazine in July 1976.



BELOW A Minitel terminal is given a new lease of life as a laptop

"Raspberry Pis are well suited to making retro productions because of their low cost and high performance"

According to maker Michael Gardi, just 12,000 of these were ever made, but he decided to create a full-sized replica based around a Raspberry Pi 4 running an 8080 emulator. Looking just like the images in the magazine, it supports a virtual tape drive and video output. "It had more in common with the Altair 8800s and IMSAI 8080s of the day than it did with the Apple and Commodore computers that would soon follow," Gardi said.

In his view, taking old machines and recreating them using a Pi is educational. "I'm interested in shining a light on some of these historically significant machines that were the stepping stone to the personal computing world we live in today," he explained.

He points to the SOL-20's importance to Apple's history, for example, explaining that Steve Jobs and Steve Wozniak had arrived at the first annual Personal Computer Festival with their Apple I in a cigar box, believing it to be better than the competition.

"There was just one thing nagging at Jobs: the SOL-20," said Gardi. "Jobs was confident his product had the best circuitry but the SOL-20 was better looking. It's a funny coincidence that the Apple II also looked more like a professional machine with a built-in keyboard and power supply."

Gardi loves replicated old computers and once used a Raspberry Pi in a scaled-down replica of a DEC VT100. Detailing such creations at **mikesmakes.ca**, it's proof of the Pi's worth to the retro community.

"Raspberry Pis are well suited to making retro productions because of their low cost and high performance," Gardi said. "They also have numerous GPIO pins for external hardware, many available HATs and Python built into Raspberry Pi OS.

"Creating the reproductions has tremendous educational value and I believe the devices of old and their designers deserve to be remembered and honoured. I'm sure the purists out there would disagree, but retro computers that make use of Raspberry Pis are just as interesting and nostalgic as the original machines, especially if obtaining an original is next to impossible." ●

Futures

We explore the trends and technologies that are set to shape the future

Keeping driverless cars on the road in snow

Wintry conditions are a challenge for human drivers, let alone automated systems. Nicole Kobie reveals the efforts to make self-driving cars safe in snow

ABOVE **The Waterloo "Autonomoose" has eight cameras to guide it in snowy conditions**

Whenever the first snowfall of the year blankets Calgary, the Canadian city I grew up in, the roads swiftly become lined with cars that have spun out of their lanes. There's a distinctly Canadian remark that comes along with spotting a car caught up in the annual mass fender-bender – "must be new" – based on the assumption that all the roadside wipeouts are clearly recent arrivals to town. After all, anyone who's lived locally for a year is forced the hard way to learn how to drive in snow, so anyone slip-sliding across the motorway must be a newbie.

There are many tricks to driving in snowy conditions, but here are a few: drive slowly, even slower than you think you should; if snow obscures the lane markings, follow the lights of the car ahead; when slipping on ice, braking can make it worse.

Teaching such lessons to a human driver is hard enough, so how do we ensure driverless cars can manage in inclement winter weather?

Most of the big automated vehicle test projects are run in warmer climates – largely California and Arizona – and weather has already proven a challenge, with reports suggesting Alphabet's Waymo car struggled with intense rain, sparking a trial in Florida during the wet season to collect better data and solve such challenges. "Elon Musk says driverless cars will be here tomorrow – I don't think that's true," said Nathir Rawashdeh, assistant professor at the College of Computing at Michigan Technological University (MTU). "In Silicon Valley, they always have nice weather. And in order to deal with the challenges of bad weather, you need to have a lot of data to train your artificial intelligence."

But there is work being done in colder locations, far away from Silicon Valley, in an attempt to let driverless cars operate further north than southern US states. A Waymo spokesperson notes that its cars have now been tested in more than 25 American cities, including snow trials in Washington, Detroit and Michigan, with cold weather projects in the works as far back as 2012 paired with simulation to address such challenges. In Canada, researchers are developing a database of wintry driving scenarios using a car named after a moose. In the Nordic countries, robotics researchers are working on software to help teach driverless cars not to slip on ice. And in Michigan, academics are analysing sensors to improve autonomy in the snow.

> **"In order to deal with the challenges of bad weather, you need to have a lot of data to train your artificial intelligence"**

Seeing and reacting to snow

There are two challenges to automated winter driving, says Krzysztof Czarnecki, director of the Waterloo Intelligent Systems Engineering Lab at the University of Waterloo. The first is perception, the second is driving itself. "Winter essentially degrades the ability to see," he said, explaining that when it's actively snowing, cameras struggle to see as much as humans.

Paivsa
X-473

ABOVE Sensible 4's software doesn't rely on road markings for vehicle positioning

Other sensors are also troubled by cold weather, as ice changes how Lidar lasers reflect, causing errors. Radar can still see through snow, but its resolution isn't detailed enough for precise decisions when driving. What's more, in extremely cold conditions, any sensor can freeze or ice over.

Even when sensors can see, algorithms have to identify objects that are now blanketed in snow, including lane markings that are heavily relied upon by driverless technologies to accurately position cars. "You have to train your algorithms to work in snowy conditions," said Czarnecki. "AI can be better than humans, but if you make small changes to [what it sees], like adding rain or snow, and it hasn't been trained on such images, it doesn't work well."

Perception aside, automated cars still need to be taught how to change their reactions to drive safely in challenging conditions. "If it's slippery, your controllers have to operate in a completely different way," said Czarnecki. "You have to estimate the road friction, and that's not a trivial problem."

And consider driving on roads with obscured lane markings: in a snowstorm, human drivers will turn two lanes into one, slowly straddling both for more room. "Traffic sort of self-organises," said Czarnecki. "You have to see how others are driving… the challenge with that is recognising these things on the fly and being sure that it's safe and no mistakes are being made. The thing is that AI doesn't have any common sense. It can only follow rules that you bake into it or give it by example."

Sensor fusion for safer snow driving

The Keweenaw Peninsula in the state of Michigan gets more than 500cm of snow each winter, so it's no surprise that researchers, including Nathir Rawashdeh at MTU, are working on ways to help driverless sensors work better in winter weather.

At the core of the research is the idea of sensor fusion: letting each type of sensor – Lidar, radar, cameras and so on – work in concert to make up for each other's flaws. "A car should have different sensors on it, not just one type, because if one type fails, say in the rain, maybe the Lidar or the camera will still see things right," Rawashdeh said.

In one example, the researchers said a deer was captured in an image taken by the team's driverless car. Lidar said it wasn't an obstacle of note and the cameras believed it was a sleeping person at the wheel of a vehicle, but an infrared sensor correctly realised it was an animal that could move into the way. The aim of sensor fusion is to combine all sensor data to improve a driving system's odds of spotting real issues.

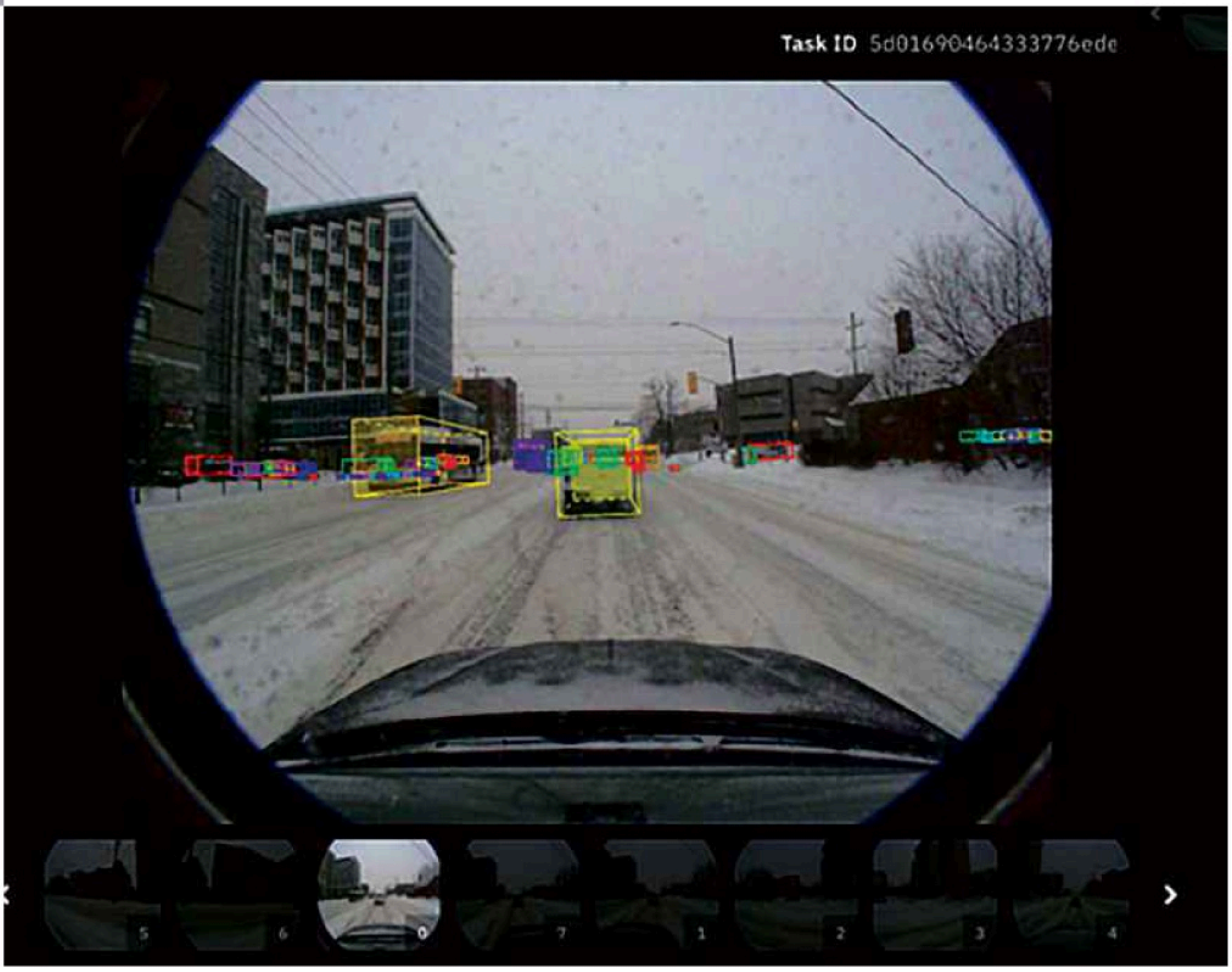
"The thing is that AI doesn't have any common sense. It can only follow rules that you bake into it or give it by example"

That work has been supported by years of collecting data on winter conditions, to better train the cars, but the researchers are also using datasets produced by other universities, including a project at Heriot-Watt University in Scotland. Using such winter data sets, Rawashdeh is developing a weather-detecting system, to help cars understand what sort of snow or rain is happening outside.

"For a human it's easy, but for a machine, it's harder to know is it raining or snowing, overcast or foggy," Rawashdeh said. "If the car knows the weather conditions, it can engage the appropriate algorithms for driving in the snow."

Sensible snow driving

When I speak to Harri Santamala, the CEO of Finnish automation firm Sensible 4, his Zoom background is a vehicle driving through hilariously wintery conditions. "It was taken last winter from one of the suburbs in Oslo," he said. "There was heavy snowfall, with 40 centimetres or so coming in during the day, which is a lot even for the Nordics. We had a pilot project to serve the last mile of transportation in the local region, and took the picture after it had been operating the whole day. We're really happy that it was functioning when conventional vehicles started to get stuck."



BELOW Objects such as trees, road signs and buildings can help build a digital map

ABOVE Sensible 4's software helps other companies' vehicles navigate snowy roads

While Californian developers may have forgotten to consider such conditions, Santamala says it's impossible to ignore the weather in Finland. "We basically have eight seasons; seven of them are snowy and one is a bit rainy, and sometimes can be sunny." And most people in the world actually live in places with extreme weather, he adds, whether it's blowing snow or heavy tropical rain.

Sensible 4 doesn't build driverless cars, but develops software to help other companies' creations navigate through inclement weather, including fog and snow. "It's something that the industry needs in order to become mainstream and commercial, not just in a few spots where you have a friendly climate," Santamala said. To develop the software and add new features, data is key, so the company is also building a database of bad weather, he adds.

Sensible 4 has two products: the first is a set of modular tools to improve bad-weather performance in existing systems, the other is a full driving solution targeted at last-mile operations. The software has a couple of core capabilities. One is that it doesn't rely, as so many driverless systems do, on lane markings to position cars in the road. That's not only because ice and snow can obscure them, but because many Nordic vehicles in the winter use tyres with studs in them, which can damage asphalt and remove lane marking paint. Instead, Sensible 4 uses objects such as trees, road signs or buildings to build a digital map for positioning and location, though this technique needs to be robust, Santamala says, to work even when leaves fall from trees or snow blankets the landscape.

The software also filters perception data to remove falling snow or dirty windshields to help algorithms better understand what they're seeing. "It's about how much you can still see after taking all that noise away," he said. "For self-driving vehicles, there's no reason why we couldn't drive in any conditions where humans can drive as well... the advantage is we have full vision around a vehicle and we have several different sensors."

Lastly, Sensible 4 aims to give control systems the ability to slow down when they don't know what's in the road or if the system senses that roads are slippery. "That helps us slow down in advance or adjust the control before we're in an unsteady situation," he said.

Winter in Waterloo

It snows in Waterloo, Ontario, a city near Toronto in Canada, any time between October and May. In January, it will snow more days than not, with an average 44cm falling that month. That's why the local university is home to a project helping to teach driverless cars to see and understand winter conditions.

It's here that Czarnecki is working to address the perception side of the challenge by collecting data to train autonomous vehicles to handle winter weather, in particular snow. Working alongside the University of Toronto, he and his fellow researchers have created the open-source Canadian Adverse Driving Conditions Dataset (CADC), a collection of carefully labelled video clips for driverless AI developers to use to accurately train their own algorithms and artificial intelligence.

"It's a matter of collecting data, so companies and other researchers can innovate their algorithms and see how well they actually work in recognising road users or objects on the road under these conditions," he said.

The data clips were collected by Waterloo's own automated car. Dubbed "Autonomoose", it has eight cameras, a 360-degree Lidar scanner, and GPS for tracking location. It was sent out over two winters to collect examples of snowy conditions, as there are plenty of different scenarios that Californian driverless developers may not have considered, says Czarnecki.

"There are some examples in our dataset where people are operating a snow blower – you can have a perfect winter snowfall [in the dataset], but then you have these clouds of snow coming from a snowblower, and that's quite different from normal snow," he explained. "These are the kinds of things that you only find out when you operate in this environment."

Indeed, Czarnecki admits it's not possible for Waterloo alone to build a dataset that can capture weather in all its forms. One solution being trialled is simulating snowy conditions, to add it to existing data sets. Another is to teach automation systems to better understand uncertainty. Some AI uses confidence scores to show how sure it is of what it sees and understands, but Czarnecki says they can be misleading. "Sometimes AI is overconfident, it's actually a typical problem with deep neural networks," he said. When human drivers can't see through a storm, we drive slower and keep to the centre of roads – driverless systems need to learn to be that flexible, too.

> **"The technology has the potential to reduce accidents and be better than a human driver, but it will take time to get there"**

How does the Autonomoose handle winter, after years of training? Conditions are so challenging that it's kept to an approved geo-fenced testing area. Czarnecki says a journalist from the CBC went for a ride a few years back; the car slid around the test track, spun its wheels, and was confused by snowdrifts. "It's very challenging," Czarnecki said. "We have to have some patience... I do think that the technology has the potential in the long term to reduce accidents and be better than a human driver, but it will take time to get there." Just like driving in the snow, driverless cars that work in snow could be a slow, careful journey. ●

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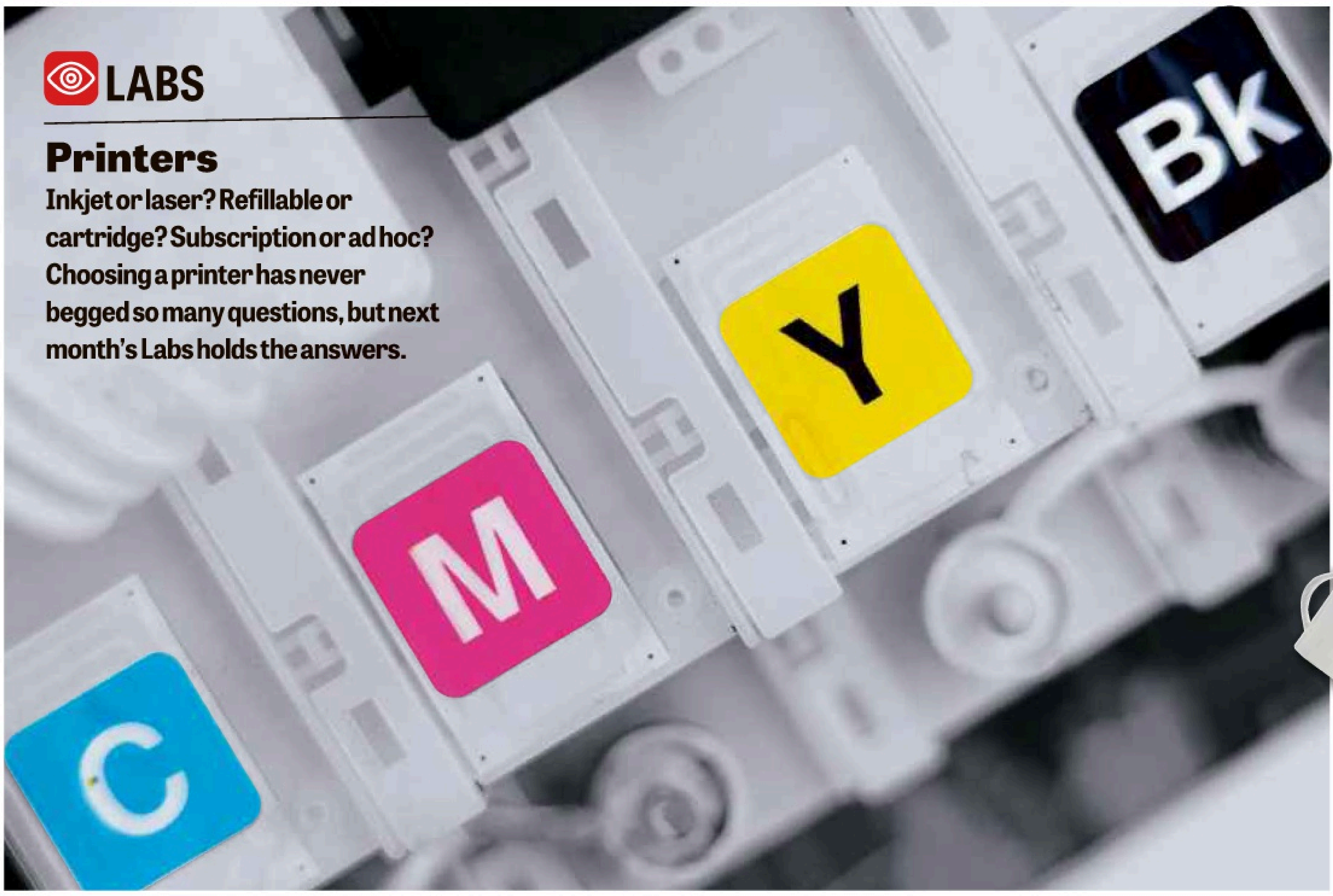

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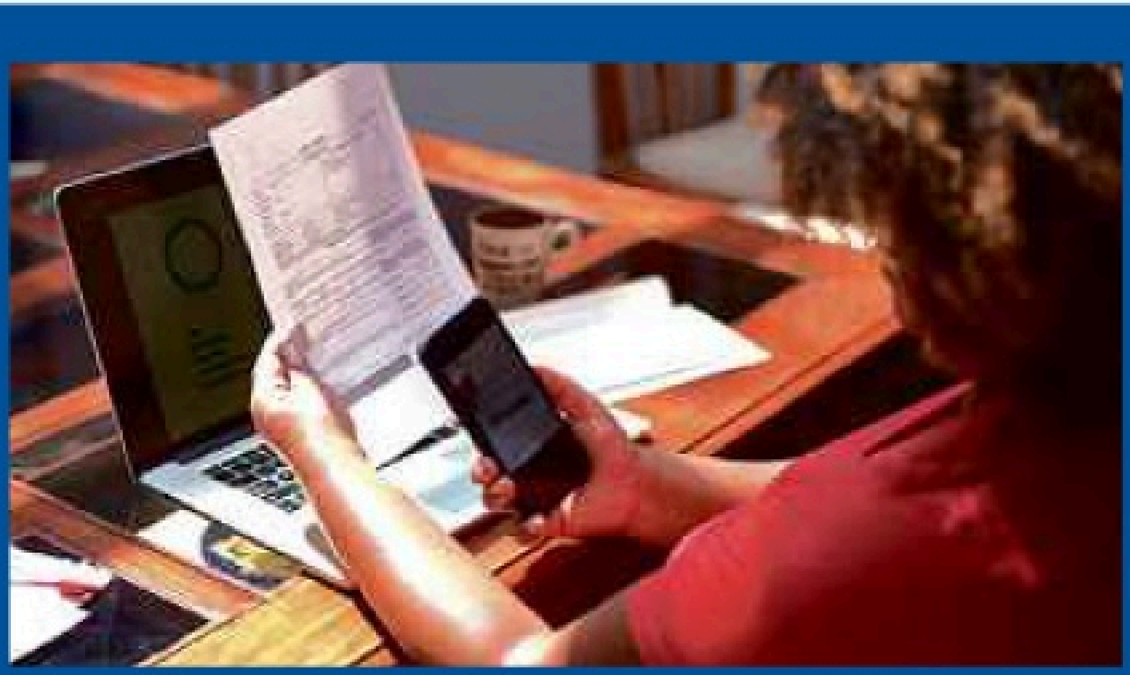

Turn your phone into a high-end scanner

We've all used our phone to snap documents, but that's merely skimming the surface of what it can achieve. OCR, translation and document management are just a snap away.

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NFTs: what's the point?

Most of us at *PC Pro* are struggling to see the point of non-fungible tokens and are concerned about potential environmental implications. Can we be won over? Find out next month.

Please note: Labs and features are subject to change

Now that the smartphone is old hat, Jon Honeyball looks forward to a new era of computing

We are moving into the post-smartphone era. That might come as a shock to you, but the smartphone has had a decent run – depending of course on what you call a "smartphone". For most of us, the category was kicked off by the iPhone well over a decade ago: its full-face touchscreen and rich software ecosystem have simply transformed the world.

Those with long memories might hark back to devices such as the Nokia Communicator or the Palm Treo, while others might pin their flags to the Android pole, but it's indisputable that Apple has done more with the smartphone platform than anyone else. In particular, it's almost single-handedly ushered in the successor phase of personal technology: the age of wearables.

For me, the Apple Watch has been as transformative as the phone itself. Over the past few years it's gone from a wrist-worn curiosity to an integral part of my portable communications toolkit – so much so that if I leave it at home in the morning by mistake, I will drive back to get it.

Who's that smirking at the back? I'm being entirely serious. I make many of my phone calls through my watch, and do much of my messaging and email browsing there too. It took some initial time and thought to set up the watch face for quick access to these features, but now that's done it's far easier to glance at my wrist than to pull the phone from my trouser pocket. I know some *PC Pro* colleagues swear by their Android smartwatches, but in my experience they simply don't manage the trick of making 2+2=5.

Needless to say, the march of evolution doesn't stop here. The ongoing chatter about VR and AR systems is growing louder and more widespread. VR has been around for ages, of course, without really going mainstream – even Sony's VR headset for the PlayStation has never struck populist gold. But then there's an essential problem with VR: you immerse yourself in a virtual world to the exclusion of everything else. That works well when you're on the sofa playing a 3D game, but falls down when you need to go to the fridge to get another beer, and collapses entirely when it's time to drive to the shops.

AR has a far better chance of gaining public traction, because it lets you reap the benefits of connected technology while remaining in contact with the real world. There are still issues to be overcome, however. One is portability: a typical VR headset is big enough to accommodate essential components like batteries, or if you need more power, you can alweys run a tether cable back to a base unit – after all, VR users aren't likely to be wandering any great distance.

It's much harder to design a practical AR device. Yes, you can use AR capabilities on a phone or tablet, and that's useful because it expands the range of use cases, but ideally you want something that you can wear on your person at all times. This means it has to be light enough not to impose on your movement, and discreet enough to fit seamlessly into your everyday life, while still being able to do a useful job for the wearer, and to store enough power to carry on working for a reasonable period between charges.

One solution might be to integrate AR into a pair of headphones. This would allow for advanced binaural audio support, with mountings for cameras on the headband and extra space for batteries. Or, such a device could use a small tether cable to a battery and CPU lump that you can store in a pocket. It would also need high-speed networking to your smartphone, assuming this remains the core of the portable information network, but this should be possible with high frequency wireless working as a personal pico-cell.

Even if such a design can be made to work, there are deeper questions that need addressing. What are we actually going to do with AR? Will the combination of smartphone, smartwatch and smart glasses ever achieve the promise of 2+2+2=9?

> "What are we actually going to do with AR? Will the combination of smartphone, smartwatch and smart glasses ever achieve the promise of 2+2+2=9?"

As yet we have few answers. Microsoft has been beavering away on its VR/AR HoloLens system for more than five years now, but hasn't so far delivered anything mainstream. Apple is reportedly also working on an AR product, but it's unclear what form it might take. On the plus side, the company's powerful ARKit framework is already powering a wide range of iOS apps.

That's not enough though. If AR is to work, it has to work across the whole spread of of devices. Maybe Apple will make 2+2+2 equal 9, but will that magic calculus be available to everyone? It would be a true step forward if the next era transcended manufacturers' ecosystems; I'm not holding my breath.

Jon Honeyball has been a contributing editor to *PC Pro* since issue one, which is surprising when his two-times table is so poor. Email jon@jonhoneyball.com

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